POWER PLANT ENGINEERING

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Dr. Browne and Dr. Slepian of the Westinghouse Research Laboratories with their equipment for photographing arcs under water

Noah In Reverse

WHEN OLD NOAH piled his menagerie into the ark and set his course for Mt. Ararat, he had one main objective; that was to keep the ark above water. In doing this he set a precedent and ever since electrical engineers have had practically the same objective; they also have been concerned with keeping arcs above water, the only difference being that they spelled arc with a C whereas Noah spelled it with a K, a small matter in our opinion. But this is a changing world and nothing seems to be sacred anymore, not even practice regarding the arc and now we find Westinghouse engineers engaged in the strange pastime of keeping an arc under water. Above you see a picture of Dr. Browne and Dr. Slepian with a gadget they rigged up in the Westinghouse laboratories for not only keeping the arc under water but for taking pictures of the arc during its struggles against drowning. Now, arcs do not like to be under water and our first impulse when we heard of this cruel practice was to call the SPCA (Society for the Prevention of Cruelty to Arcs) but Westinghouse assured us that they were doing the world a good turn. Arcs, it seems, are snakes in the grass or skunks or something and should be exterminated, and in rigging up this complicated equipment they are only trying to find out how to effect this exterminating process most effectively. ¶ Because the arc either lives or dies as a result of what happens just before the instant at which its current falls to zero, most of the pictures are taken during that brief struggle against extinction. From a rogues' arc gallery of more than a thousand pictures Dr. Browne has found that an abundance of gas between the electrodes at this critical instant seems to breathe new life into the arc, while its death pangs are almost always presaged by a relative dearth of gas within the bubbles. Well, that's the story; it's rather hard on the arc but it makes for better circuit breakers.

WITH THE EDITORS

War and Power

REGARDLESS of whether war comes to this country, the rearmament program outlined by the President will undoubtedly be carried through and throw a severe strain on both the utility and private power plants.

Fortunately the heavy construction program in force during the past two or three years has done much to bring a few of the key plants up to modern standards. There are, however, thousands of the older and smaller plants which still constitute a menace to the safety and security of the nation.

The danger lies not so much in the safety of the equipment itself and danger of industrial delays due to equipment failure, as it does to the added burden thrown upon our transportation and coal producing facilities.

Efficiencies of these older plants runs at a modest estimate 20 per cent below present standards and in many cases is double that. More important, however, this older firing equipment, whether it be stokers or hand firing, demands a good grade of sized fuel for heavy continuous emergency service. The low efficiency means extra transportation facilities while the high quality fuel means a diversion of this grade from some more important service, leaving an excess of low grade screenings at the mine.

Quite aside from the national issues involved, modernization of boiler plant facilities can be expected to pay good dividends on the investment required. Increases in efficiency plus the savings per ton of screenings over high grade sized coal will involve a fixed saving of from 25 to 50 per cent. More than ever before it is the duty of every engineer to take stock of his plant, prepare the necessary savings and estimates of a modernization program and lay the matter before the management.

They Also Serve

WITH the papers filled with blitzkrieg and rearmament, it is difficult to concentrate on power plants, even with the knowledge that stationary and portable power plants are an essential of modern war and that the Diesel is destined to play an important role both in planes and in tanks.

In itself 50,000 airplanes is a bit breath taking because it represents a tremendous increase in production over our normal 1939 capacity of perhaps 3000 annually but it also means training 60,000 to 70,000 pilots, to say nothing of three to four times this number in the ground crews.

Nevertheless, it probably can be done under pressure. Certainly the industrialists who carry it through will have their share of well deserved praise, which must, however, be shared with the politicians who do the heavy thinking. Equally certain is the fact that no public recognition will be given to those men in the war and other government departments who for years, under the handicaps of limited funds and general public apathy, even hostility, have been quietly and efficiently planning for just such an emergency.

Based on experience in the last war, improved production methods, changes in details of warfare and the added complications of industrial organization, these men have planned carefully. Few are familiar with the close cooperation of various departments and groups, surveys of essential materials, detailed provisions for the hundreds of army needs and safeguards of transportation facilities and labor reserves which will make possible transition to a wartime basis without demoralizing normal industrial production. The seemingly undue interest which the War Department displays in waterways is less difficult to understand when considered in the light of the vulnerability of railroads to aerial attacks.

And incidentally, based on 1939 conditions, the production capacity of 12 men is one plane per year and the average cost of a well balanced military air force runs from $40,000 to $45,000 per plane. Standardization will undoubtedly make drastic reductions in both cost and labor requirements. The automotive industry can be depended upon to supply certain deficiencies in skilled labor, principally tool and die makers, without interfering with essential production. So while 50,000 planes is quite an order it is not an impossibility. When you see some of the 50,000 overhead give a thought to those anonymous individuals who greased the skids before the launching. Outside of the knowledge of a job well done under severe handicaps it's all the credit they get.

A Thousand Airplanes a Day

AS POINTED out in another paragraph on this page, the plan to produce 50,000 airplanes in this country is quite breathtaking but it probably can be accomplished. Certainly when such an industrialist as Henry Ford says that he can produce a thousand airplanes a day, and according to the newspapers he is reported to have said that, we would be presumptuous to argue the point. It should be pointed out, however, that the 1000 airplanes a day production schedule mentioned in press reports do not stand alone, they only form part of the larger picture. Airplanes in war require guns and high explosives, bombs, etc. Aside from the personnel required to maintain them, the auxiliary services required are enormous and so our industrial production must be geared to produce all of these auxiliary materials in addition to the airplanes. These matters must not be lost sight of and these matters account for the difference in optimism between our industrialists and army officials. The army officials know the picture as a whole too well to be misled in attitudes of false security by the well meant opinions of those whose concern is with only a part of the whole.

Electric Plant Adorns Swamp

Long accustomed to owning and operating its own electric power plant and distribution system, the City of Holland, Mich., nationally famed for the growing and displaying of tulips and maintaining other Dutch traditions, has just put into operation an entirely new power plant of 15,000 kw. capacity, built on reclaimed swamp ground, as a P.W.A. project, at a cost of $102.90 per kw. of rated capacity.

By

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WITH electric load in the city of Holland, Michigan, steadily increasing, the old municipal power plant, known as the Fifth Street Station, has become inadequate and has been replaced by an entirely new steam electric generating station located on the new Government channel in Lake Macatawa, a bay in Lake Michigan, at the mouth of the Black River. This site near the center of the city was formerly an unsightly marsh but offered such advantages as nearness to the center of the electric load, convenience for receiving shipments of coal by rail and boat, and an ample supply of cooling water.

While the old station will provide standby service for a time, it is intended that the new plant will eventually be the sole source of power for the system without outside connection. Reliability, therefore, is of prime importance in this central station and its mechanical design was based on the principle of maximum efficiency consistent with simplicity and reliability of operation.

In the architectural design of the station an effort was made to express its purpose emphasizing simplicity and sturdiness. The result is a structure with plain lines but of very pleasing appearance, 83 ft. by 140 ft. in plan and 70 ft. high. The exterior consists of light buff colored brick with natural limestone trim. Interior walls are finished in vitreous buff colored tile with a smooth unglazed surface which gives a soft pleasing effect. Floors are finished in materials suited to their particular purpose and location, including tile and terrazzo. The site has been landscaped to conform with treatment of the building and gives the appearance of a park in contrast to the original unsightly marsh.

Fig. 1. Holland's new electric plant as seen from coal dock during construction.

General Features of Design

Steam conditions in the new station are 550 lb. gage pressure and 825 deg. F. total temperature and the installed capacity of 15,000 kw. which is divided between two identical sets of equipment designed for individual unit operation, i. e., one steam generating unit and one 7500 kw. turbine-generator with all their associated auxiliaries operating as a single unit. The only item of equipment not duplicated and common to the operation of both units is the make-up evaporator and open deaerating heater which receives the condensate from both turbines and supplies the boiler feed pumps from a common header. The piping is so arranged, however, that each boiler may serve either turbine or both turbines up to the capacity of the boiler, and any boiler feed pump may supply either boiler individually or both boilers. Provision has been made also for temporarily by-passing non-essential auxiliaries of each complete power unit in the event of trouble. The deaerating heater also can be bypassed for a time if necessary, and essential auxiliary equipment, such as condensate pumps and induced draft fans, are furnished either with steam driven auxiliary drives or are installed in duplicate, all of which reduces to a minimum the possibility of a power interruption.

The unusually wide variations in load on the plant and the great percentage of time at which it will operate at very low ratings made the use of underfeed stoker equipment advisable and elimi-

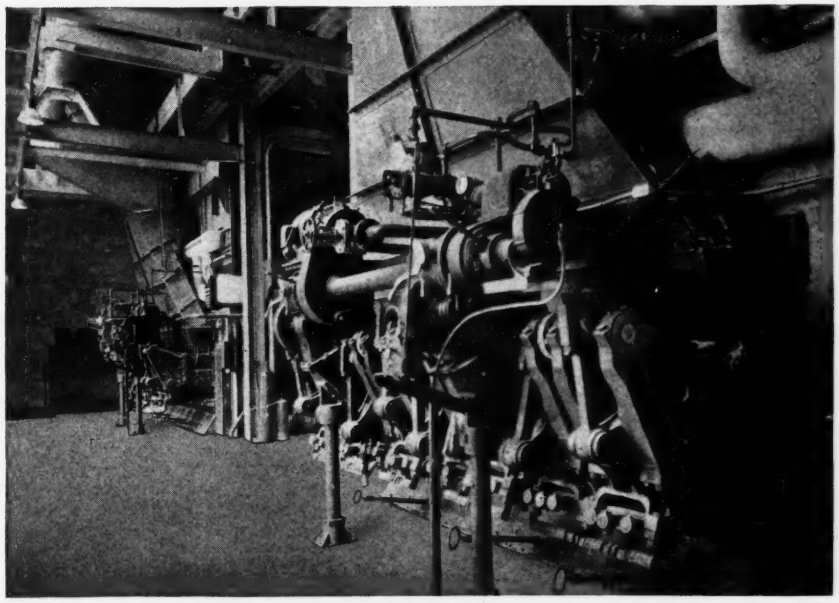

Fig. 2. Two boilers served by underfed stokers are depended upon to supply all the steam for the two turbines and auxiliaries

nated air preheaters. Provision, however, was made for the installation of a preheater at such time as improved load conditions make it practical.

The building itself is divided into three distinct rectangular sections: the boiler house, which is the largest, comprising one end; the smaller turbine house making the middle section; and the switch house, a comparatively small section, completing the other end. The sections are stepped in height according to their size, the whole providing a very convenient arrangement and economy of building volume. The building has no basement, the lowest floor being less than 2 ft. below grade and the main operating floor is 18 ft. above grade.

Two large roller-curtain doors permit access to the turbine and boiler houses at grade with provision for driving trucks directly into the building. Hatchways with removable covers allow hoisting equipment to any level in the building. The turbine room is served with 30-ton electrically operated crane.

Steam Generating Units

Two identical Edge Moor Iron Works boilers are installed which are of the three drum, bent tube type with bare tube economizer and Foster Wheeler two pass, four loop, pendant type superheater. They are designed for a maximum drum pressure of 600 lb. per sq. in. and a normal rating of 90,000 lb. of steam per hour each, with an overload peak of 112,500 lb. per hr. All four furnace walls are water cooled and protected with a belt of Bernitz carborundum block armor to a height of 3 ft. above the stoker. Each boiler is fired by a Taylor eight retort, inclined, underfeed, clinker grinder type stoker driven by a small steam turbine. Because of the difficulty of obtaining a small turbine suitable for 550 lb. and 825 deg. F., the steam for the turbine is taken from the saturated steam superheater header and reduced in pressure to 400 lb. through a reducing valve. In keeping with design standards of reliability, the stoker is also equipped with a four-speed motor for emergency use. Ash is removed periodically from the ash pit with Allen-Sherman-Hoff Co. sluicing equipment to an ash sump from which it is pumped to marsh areas adjacent to the plant. All coal siftings, soot, and fly ash from the several collecting hoppers on the boiler are discharged by gravity to the ash pit. Most of the fly ash is caught in the hopper installed below the economizer and induced draft fan where the gases, after passing downward through the economizer, make an easy reverse turn to enter the fan. The fan and economizer are set on the same level directly behind the boilers with the fan discharging into a short stack 6 ft. in dia., directly above it.

Each induced draft fan is equipped with two drives: a 125 hp., four-speed, induction motor for main drive and a 122 hp. geared steam turbine using steam at 550 lb. and 825 deg. F. for an emergency drive. The drives are on opposite ends of the fan shaft and connected to it by free-wheeling type couplings which will permit automatically shifting the load to either drive.

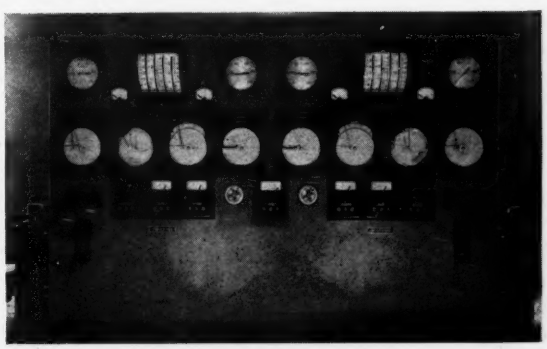

Fig. 3. The boiler control board is conveniently located facing the aisle between the boilers

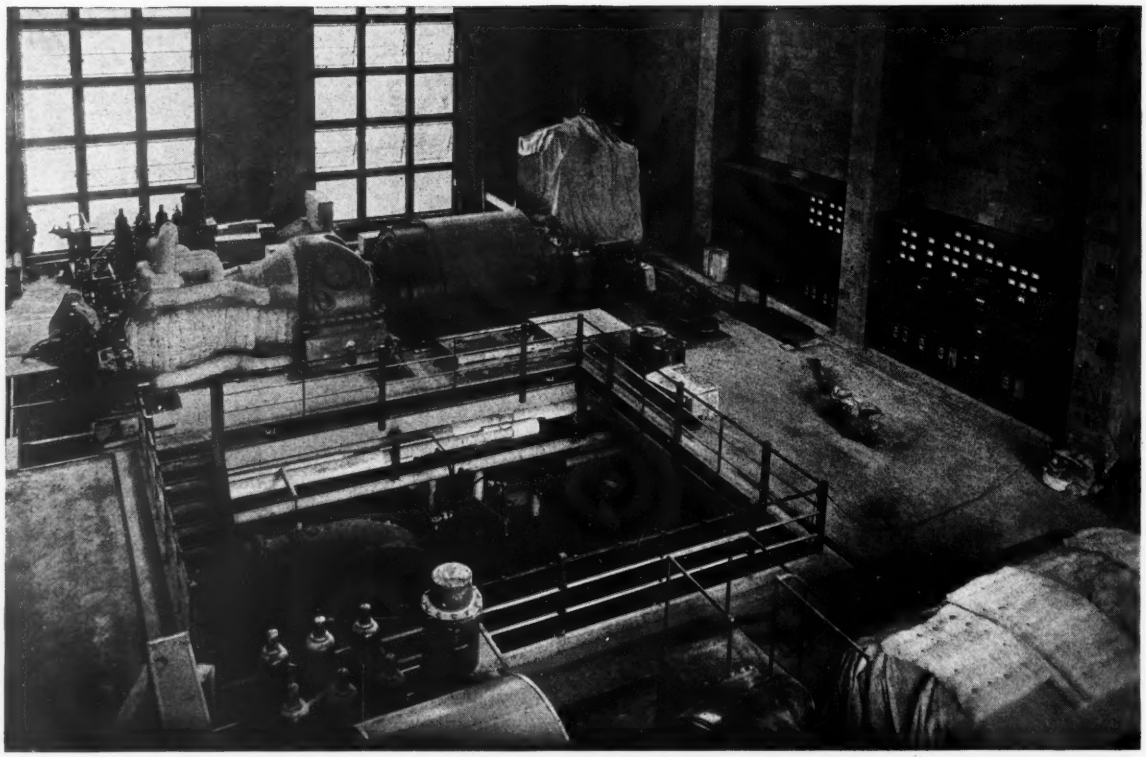

Fig. 4. One of the two turbine generating units showing a portion of the condensing equipment and one end of the control board

Forced draft fans are installed in a closed chamber constructed in front of the boilers and directly below the operating floor. Air for combustion is drawn from the upper part of the boiler house through a vertical shaft which also provides the connection to the enclosed coal bunker to keep it under a slight negative pressure. Each fan is driven by a direct connected, 60-hp., four-speed motor. No auxiliary drive is provided since the induced draft fan alone can provide sufficient draft to carry a fair rating on the unit.

Manual manipulation is employed for the four-speed fan motors to change from one step to the next, a signal light and bell on the control panel announcing the need for changing and the direction. Automatically operated dampers on both fans accurately control the flow of gases.

Each steam generating unit is controlled by a Hays electrically operated, fully automatic, combustion control system which is complete with all the necessary meters, gages and instruments for indicating and recording operating conditions.

Turbine Generators

Electric generating equipment, designed for maxmum efficiency at ¾ load, consists of two 7500 kw., 0.8 p.f. 3600 r.p.m. Allis-Chalmers turbines operating at 550 lb. pressure and 825 deg. F. direct connected to 9375 kv-a., 60 cycle, 3 ph., 4 wire 2400/4160 v. air cooled generator and 40 kw. capacity exciter. A spare turbine driven exciter is also provided for the plant. Each turbine exhausts into a spring supported 8500 sq. ft. C. H. Wheeler two-pass surface condenser furnished with auxiliaries by the same manufacturer.

Cooling water from conduits from the lake constructed directly below the turbine foundations is circulated through the condenser by two 14-in. horizontal, single stage, bottom suction, centrifugal pumps with a combined capacity of 9900 g.p.m. The pumps are primed by means of a steam ejector connected to the condenser water box. Each condenser is also served by two two-stage centrifugal condensate pumps and a dual two-stage steam jet air pump. This unit is provided throughout with dual equipment, any single pump of which has sufficient capacity when operating alone to permit the turbine to carry close to its rated load.

Electric power for each half of the double system is supplied by separate station power systems from the main plant busses. Provision has also been made for supplying the condensers with a limited amount of city water in the event of serious ice trouble at the intake screens, although provision is made for recirculating a part of the warm return water to the intake as required to prevent clogging intake screen with ice in winter.

Feedwater System

Condensate is passed through the generator air cooler and steam jet air pump condensers on its return to the boilers. Since this is the only provision made for cooling these units, to insure adequate cooling during the summer months when circulating water temperatures may be unusually high, an auxiliary closed heat exchanger has been provided

for cooling the condensate when necessary before it enters the air cooler. Provision is also made for recirculating condensate automatically by means of a thermostatically controlled valve in the event the load drops to a point at which there is not sufficient condensate to properly serve the air cooler and air pump condensers.

Three-stage feedwater heating is provided with two closed heaters and one open deaerating heater. The open heater is supplied from the intermediate bleeder nozzle and auxiliary exhaust steam if any, and operates at about 10 lb. gage. One of the closed heaters is installed between the boiler feed pump and the boiler and is supplied from the highest pressure bleed nozzle. The other is installed between the condensate pump and the deaerator and is supplied from the lowest pressure bleeder. When operating under low load conditions, however, the pressures at the various bleeder nozzles are not sufficient to operate their respective equipment. To overcome this, an auxiliary bleeder connection was made from the first stage of the turbine and a series of pressure reducing valves arranged to permit automatically supplying the equipment connected to each bleeder nozzle from the next higher pressure nozzle while operating under light load.

All make-up water for the plant is supplied by an evaporator. All the closed heaters are located in the boiler house on a platform behind and below the main operating floor. The boiler feed pumps are placed on the operating floor directly above and the deaerating heater and evaporator are above the pumps on the same level as the induced draft fans and economizers and in the center aisle between the fans. This conveniently groups all the feedwater equipment in a vertical space in the center of the station.

Approximately 4000 gal. of condensate storage is provided in two cylindrical surge tanks installed on the same level as the evaporator, deaerator, and induced draft fans. These tanks are vented to the deaerating heater.

Three DeLaval, six stage, centrifugal, boiler feed pumps are installed, each capable of delivering 148 g.p.m. of 240 deg. water against 750 lb. gage pressure. Two of the pumps are driven by 125-hp. electric motors and the third by a non-condensing steam turbine. The pumps discharge into two separate headers. One, the main header, passes the feedwater through the high-pressure closed heater, the feedwater regulating valves, and the economizer on its way to the boiler drum. The other, an auxiliary header, feeds directly to the boiler drum with manually operated throttling valves for controlling the flow. The piping is so arranged that any pump can discharge to either or both headers and either boiler can be fed from either header. Both the closed heater and the economizer can be by-passed with the feedwater.

Piping and Instruments

Except for connections to equipment, some small drain lines, and similar items, the piping was welded throughout. All welding on the high pressure and high temperature steam piping was done in the shop and stress relieved. Where field joints were required they were flanged. All joints in this high-pressure piping were made with grooved flanges and soft iron octagon ring gaskets.

All the large valves in the main steam lines are motor operated by remote control. Each of the bleed lines from the turbines has an oil operated check valve connected into the turbine oiling system to insure positive checking of any back flow through the lines which might injure the turbine.

(Continued on page 49)

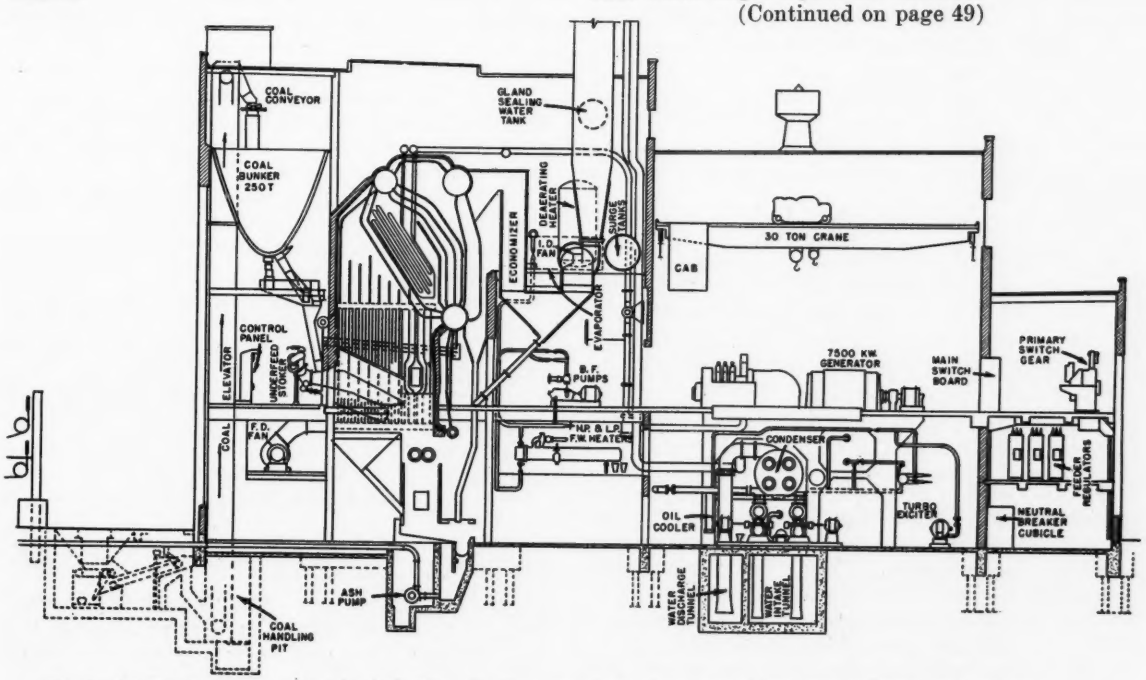

Fig. 5. Longitudinal section through plant shows all power equipment above ground level except tunnels and coal pit

Notes on Combustion Calculations

Part II. Application of the molar system of calculating combustion problems is made to gaseous fuel in this second and last article of the series.

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ASSUME that a certain gaseous fuel has the volumetric analysis shown in Table II. In the example published in the June issue, preliminary calculations were made for 100 lb. of fuel. In this second example, calculations will be made for 100 mols fuel since it is a more convenient unit to work with.

Solution: General.—The preliminary work in the solution of problems involving this type fuel is the same as in the previous example and will not be discussed further. Exclusive of columns 9, 10 and 11 which will be explained later, the arrangement of the table is the same as used in Table I, page 47 of the June issue. It should be noted, however, that the results are given in *mols per 100 mols of* fuel instead of mols per 100 lb. fuel. While it is not necessary that the tabular method of solution be used, it is strongly recommended in order that the engineer learn to proceed in an orderly fashion so that his work may be readily checked by himself as well as by others.

Let it be desired to calculate the following items when the fuel is burned with 50 per cent excess air:

(a) Cubic feet of air required per cubic foot of fuel. (Air and fuel at same pressure and temperature.)
(b) Volume of each product of combusion in cubic feet per cubic foot of fuel. (Same pressure and temperature.)
(c) Volumetric analysis of the products of combustion.
(d) Gravimetric analysis of fuel.
(e) Cubic feet of air at 14.7 lb. per sq. in. abs. and 80 deg. F. required per pound of fuel.
(f) Pounds of air required per cubic foot of fuel at 15 lb. per sq. in. abs. and 200 deg. F.
(g) The weight of air required per pound of fuel.

Solution (a) Cubic feet of air required per cubic foot of fuel.

From column 4, line 9 it is found that 135 mols O_2 are required from the air for each 100 mols of fuel burned under the assumed conditions. Therefore there would be $135 \times 4.78 = 645$ mols of air required per 100 mols of fuel (or cubic feet of air per cubic foot of fuel when measured at the same pressure and temperature). The desired answer would then be $645 \div 100 = 6.45$ cu. ft. air/cu. ft. fuel.

(b) Volume of each product of combustion in cubic feet per cubic foot of fuel.
(c) Volumetric analysis of the products of combustion.

The volume of each of the products of combustion in cubic feet per 100 cubic feet of fuel may be read directly from line 9. The volume per cubic foot of fuel would then be:

Constituent	cu. ft. per cu. ft. fuel		Per cent by volume
CO_2	0.90	$\frac{0.9}{7.253} \times 100 =$	12.41
H_2O	0.60	$\frac{0.6}{7.253} \times 100 =$	8.28
N_2	5.303	$\frac{5.303}{7.253} \times 100 =$	73.10
O_2	0.45	$\frac{0.45}{7.253} \times 100 =$	6.21
Total	7.253		100.00

(d) Gravimetric analysis of the fuel.

One hundred mols of fuel weigh 2720 lb. as shown in line 7 column 10. This was determined by adding the weights of the various constituents, thus: 20 mols of C_2H_2 weighing 26 lb./mol = 520 lb., 20 mols of CH_4 weighing 16 lb./mol = 320 lb., etc., the complete values being given in columns 2, 9, and 10. The gravimetric analysis shown in column 11 was then found by dividing the weight of each constituent in the fuel by the weight of the total and multiplying by 100 so as to express the result in per cent or in pounds per 100 pounds of fuel.

(e) Cubic feet of air at 14.7 lb. per sq. in. abs. and 80 deg. F. required per pound of fuel.

For the conditions of pressure and temperature specified, one mol of any gas would occupy $\frac{1544 \times 540}{14.7 \times 144}$ = 394 cu. ft. The required answer would then be (135 mols O_2/100 mols fuel × 4.78 mol air/mol O_2 × 394 cu. ft. air/mol air) ÷ (2720 lb. fuel/100 mols fuel) = 93.4 cu. ft. air/lb. fuel.

(f) Pounds of air required per cubic foot of fuel at 15 lb. per sq. in. abs. and 200 deg. F.

One mol of fuel at the specified conditions would occupy $\frac{1544 \times 660}{15 \times 144}$ = 472 cu. ft. The weight of air required per cubic foot of fuel would then be: (135 mols O_2/100 mols fuel × 4.78 mols air/mol O_2 × 28.94 air/mol air) ÷ (472 × 100 cu. ft. fuel/100 mol fuel) = 0.396 lb. air per cu. ft. fuel.

TABLE II. Fuel Analysis Given on a Volumetric Basis

FUEL			REACTION	MOLS/100 MOLS OF FUEL							
Constituent		% by volume or mols/ 100 mols		O_2 from air	Products of Combustion				Wt. of Constituent Pounds per mol	Wt. per 100 mols fuel	Pounds per 100 Pounds of fuel
					CO_2	H_2O	N_2	O_2			
	1	2	3	4	5	6	7	8	9	10	11
1	C_2H_2	20	$2C_2H_2+5O_2 \rightarrow 4CO_2+2H_2O$ 2 mols+5 mols4 $\rightarrow$ mols+2 mols	50	40	20			26	520	19.12
2	CH_4	20	$CH_4+2O_2 \rightarrow CO_2+2H_2O$ 1 mol+2 mols $\rightarrow$ 1 mol+2 mols	40	20	40			16	320	11.76
3	CO	20	$2CO+O_2 \rightarrow 2CO_2$ 2 mols+1 mol $\rightarrow$ 2 mols	10	20				28	560	20.59
4	CO	10			10				44	440	16.18
5	N_2	20					20		28	560	20.59
6	O_2	10		−10					32	320	11.76
7	O_2 and N_2 from air (Perfect Comb.)			90			340.2		Total	2720	100.00
8	50% excess air			45			170.1	45			
9	Results for combustion with 50% excess air			135	90	60	530.3	45			

(g) The weight of air required per pound of fuel. (135 mols O_2/100 mols fuel $\times$ 4.78 mols air/mol O_2 $\times$ 28.94 lb. air/mo. air) $\div$ (2720 lb. fuel/100 mols fuel) = 6.86 lb. air per lb. fuel.

Actual Combustion Calculations

Problems involving actual combustion (or a combination of actual and theoretical) are of major practical importance. In order to calculate a heat balance it is necessary to know the amount of air actually supplied and the flue gas produced per unit of fuel burned. This information is also necessary for calculations involving air ducts, fans, chimneys, heat exchangers, etc.

As an example assume that the bituminous coal for which theoretical calculations were made has been burned with the following results:

Pounds of coal per hour as fired	40,000
Pounds of ashpit refuse per hour	2,630
Carbon in ashpit refuse, per cent	5
Pounds of cinders collected per hour	250
Carbon in cinders, per cent	60
Orsat analysis, per cent by volume	
CO_2	12
CO	1
O_2	6

Requirements: Determine

(a) The weight of air actually supplied per pound of coal fired.

(b) The per cent excess air.

(c) The weight of dry flue gases per pound of coal fired.

(d) The loss due to incomplete combustion, B.t.u./lb. of coal as fired.

(e) The loss due to unburned carbon, B.t.u./lb. of coal as fired.

Solution: (a) The weight of air actually supplied per pound of coal fired.

It is assumed that the reader is familiar with the fact that the flue gas analysis as determined by the Orsat apparatus is on a dry basis and that the remainder is assumed to be nitrogen. Thus in the data given, $CO_2 + CO + O_2 = 19$ per cent, leaving 81 per cent nitrogen. All of the N_2 supplied by the fuel and combustion air appears in the flue gas (products of combustion). Also, all the carbon in the flue gas came from the fuel. Using these facts it is possible to determine the nitrogen supplied from the air and consequently the air supplied per pound of coal.

Referring to the Orsat analysis data, there are 12 mols CO_2 and one mol CO per 100 mols flue gas. Therefore, there are 12 mols C in the CO_2 plus one mol C in the CO, a total of 13 mols C per 100 mols flue gas.

Then: (81 mols N_2/100 mols flue gas $\times$ 28 lb. N_2/mol N_2) $\div$ (13 mols C/100 mols flue gas $\times$ 12 lb. C/mol C) = 2268 $\div$ 156 = 14.54 lb.

N_2 in the flue gas per lb. C in the flue gas. The next step is to determine the pounds of carbon in the flue gas per pound of coal burned.

During one hour there were collected 2630 lb. of ashpit refuse which contained 5 per cent carbon, and 250 lb. of cinders which contained 60 per cent carbon. From this we find that of the 40,000 $\times$ 0.6565 = 26,260 lb. of carbon fired per hour, 2630 $\times$ 0.05 + 250 $\times$ 0.6 = 131.5 + 150 = 281.5 lb. of carbon per hour was not burned. This leaves 26,260 — 281.5 = 25,978.5 lb. of C burned per hour appearing in the flue gas. Therefore, 25,978.5 $\div$ 40,000 = 0.6495 lb. of C in the flue gas per pound of coal fired.

Then 14.54 lb. N_2 in flue gas/lb. C in flue gas $\times$ 0.6495 lb. C in flue gas per pound of coal fired = 9.44 lb. N_2 in flue gas/lb. of coal as fired. (See Table I), leaving

9.44 — .0148 = 9.4252 lb. N_2 from air/lb. coal. In order to supply this amount of N_2,

9.4252 $\times$ 4.32 $\div$ 3.32 = 12.27 lb. air supplied/lb. coal fired.

Solution: (b) The per cent excess air.

6.407 mols of O_2 were required for the perfect combustion of 100 lb. of this coal (Table I). Then

Continued on Page 48

Heat-Loss Method of Determining Boiler Efficiency*

The A.S.M.E. Boiler Test Code which is now under revision will include the Heat-Loss Method of determining boiler efficiency. Theoretically, this method necessitates a heat balance accounting for all of the losses. The author discusses the items which have not been calculated in the usual heat balance and are termed—Unaccounted-for Losses, and briefly compares the accuracy of this method with the weighed method.

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ABOUT TWO YEARS ago the A.S.M.E. Boiler Test Code Committee appointed a sub-committee to draft a Heat-Loss Method for determining boiler efficiency. The work of that committee has been completed as far as they can go at the present time and they are awaiting the completion of work by two other subcommittees before the Heat-Loss Code can be incorporated in the main boiler test code.

Many engineers have used the Heat-Loss Method of testing in some form or other for a number of years. The only thing new about the idea is the fact that finally it has been given recognition by the A.S.M.E. Test Code Committee and will be included in the revised code as an alternate method of testing —of course not to replace the fuel-water-weighed method, but to be used where this method is not practical. The Test Code Committee has taken recognition of the fact that the increased size of steam-generating units has made the installation of coal and water scales for testing quite expensive, and the increase in feedwater temperatures through higher extraction, the absorption of oxygen when weighing water in open tanks, the possible hazard of diverting large quantities of water from their normal channels have all added to the desirability of finding some other method of testing a great number of boiler units. The Heat-Loss test now represents another acceptable method.

The procedure is to account for the various losses, subtract the total from 100 and obtain boiler efficiency by difference. The accuracy of the efficiency obtained by this method is of course dependent on the care exercised in obtaining these various losses. While it is admitted that a greater number of possible errors can exist in the Heat-Loss Method, they are not necessarily accumulative and the magnitude of the total errors on a test conducted with reasonable care compares favorably with the possible errors in the standard coal-water-weighed test.

Boiler performance cannot be accurately determined by the results of a single test. A series at various ratings is necessary, an "average" efficiency line must be established, and this is the figure that is used. If weighed efficiencies vary from this average line due to test conditions it is usually evident from observation or from the heat balance. When conditions appear normal and efficiencies are out of line, it is undoubtedly due to errors in coal sampling or analysis. Figure 1 may make this point clearer. These efficiency curves were plotted from actual coal-water-weighed boiler tests conducted in three different power plants. The upper curve in either series represents the Heat-Loss efficiency determined by subtracting the sum of the usually determined losses shown in the heat balance for individual tests and the "average" unaccounted-for of the series from 100 per cent. The lower curves indicate efficiency obtained from actual coal and water weights. These series were selected as examples because several of the weighed efficiencies which were out of line fell in line when calculated by the Heat-Loss Method.

This method of course necessitates a heat balance; however, a heat balance has always been regarded as

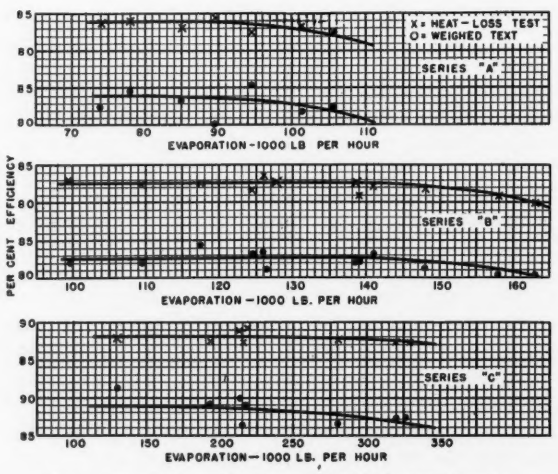

Fig. 1. Comparison, Heat-Loss and Weighed Efficiencies

* From a paper presented before the Chicago Section of the A. S. M. E. on February 14, 1940.

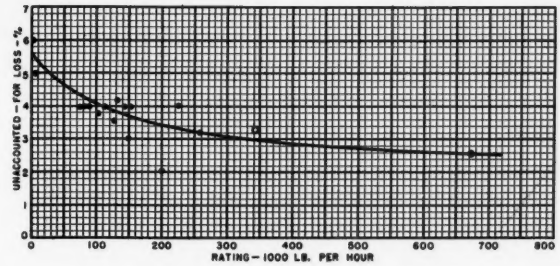

Fig. 2. "Average" unaccounted-for losses

necessary to check the accuracy of any important boiler test.

In the existing A.S.M.E. boiler code, three major items are listed as unaccounted-for: radiation, unburned hydrocarbons, and unburned hydrogen. In actual boiler test, several other items affect unaccounted-for, some of which may be considered errors; for example, the common error in not determining the actual heat value of the ash in a calorimeter, not determining loss due to fly ash on certain stoker-fired tests, or the sensible heat in the ash in other cases. The magnitude of some of these losses can represent an appreciable figure. To the above can be added the errors that might exist in determining the usual losses in the heat balance. Such discrepancies may reflect either plus or minus in the unaccounted-for. A few may bear mentioning. Thermocouple radiation tends to indicate a lower gas temperature, thus showing a lower stack loss and higher unaccounted-for. There is a tendency to take CO_2 samples in the center of the gas pass, which usually gives the highest CO_2, indicating lower excess air losses and again increasing unaccounted-for. There is a greater possibility of losing moisture in a coal sample than of gaining moisture, particularly where higher surface moisture exists. This again would increase unaccounted-for. While the effect of the individual errors is probably small, they warrant watching if accuracy is desired by the Heat-Loss test.

The extent to which these losses exist is shown by a curve plotted from a summary of the heat balance of over 100 actual boiler tests on the majority of which coal and water were actually weighed. These tests were conducted on 15 different boiler units ranging from 2000 lb. evaporation per hour to over 950,000 lb. per hour. They include both pulverized-coal and stoker-fired units, burning both eastern and mid-western coals and certainly should be a representative example of unaccounted-for losses existing on a variety of boilers and under a variety of conditions.

The tests have made evident several points; first, the magnitude of the unaccounted-for losses; second, that while radiation decreases with rating, other losses increase and the figure is practically a constant for all ratings; and third, the variation from the average line is small in the great majority of tests.

In order to summarize these losses, the "average" of each series has been plotted as a point against evaporation in 1000 lb. per hour, Fig. 2. This shows the apparent effect of boiler size on unaccounted-for loss. The curve has been termed "normal" losses since it represents the losses ordinarily reported as unaccounted-for. Two points have been corrected to bring them under this heading and since the majority of tests are within the range of 100,000 lb. to 300,000 lb. evaporation, the "average" unaccounted-for loss within this range (about 3.5 per cent) will be used as an example. It is this figure that we must try to eliminate. We have already enumerated the various items it covers.

Unaccounted-for Losses

An analysis of calculated radiation losses on several tests shows the figures to range between 0.5 and 1.7 per cent for the ordinary water-cooled unit operating between 100,000 lb. and 300,000 lb. per hr. evaporation, the figure decreasing with rating and with 1.2 per cent as a fair average for units mentioned.

Few tests have been run wherein hydrogen and hydrocarbon losses have been determined and certainly more information on this subject will be welcome. The work of Hardie and Cooper in the Brooklyn Edison Company tests represents perhaps the most detailed analysis of these losses in an actual series of boiler tests. A modified Burrell-Oberfell Orsat was used and the losses ranging from 0.2 to 2.4 per cent were charged to unburned hydrocarbons. Losses of only 0.1 to 0.2 per cent were shown for unburned hydrogen.

Perhaps one of the most common errors in calculating the heat losses in a boiler test is determining the B.t.u. of either the stack or pit refuse by loss on ignition in a muffle furnace and assuming this combustible loss to be carbon with a heat value of 14,600 B.t.u. While the error in many cases reduces unaccounted-for by charging a higher loss to the refuse than actually exists, under certain conditions it increases unaccounted-for by charging a lower loss to the refuse.

A fly ash loss of 2 per cent based on loss on ignition would be only 1 per cent based on the true B.t.u. While all of this is of course an error, it does not increase unaccounted-for as does the error when stoker pit loss is determined by this method.

While high fly ash losses are obvious on pulverizing coal units and on stokers burning some of the eastern coals, the Brooklyn Edison Company showing 8.3 per cent loss at high ratings, there are numerous coals wherein this item represents considerable loss and it is not determined.

The sensible heat in the ash or refuse, whether in pulverized coal or stoker firing, can represent an appreciable heat loss and one that usually is not calculated, thus going into unaccounted-for.

On a modern forced-draft chain-grate stoker discharging into a water-sealed pit, the temperature rise of the water (due to the heat of the ash) showed a 0.75 per cent average loss on several checks and this under "test" conditions. Under normal operation, obviously this would be greater.

In the Riverside Station tests the heat in the slag and that dissipated to the water in the slag pit represented almost 0.75 per cent of the total heat in the fuel.

The temperature rise of the water in ash pits of two pulverized coal units at Northeast Station

showed a loss representing about 0.5 per cent, part of which was no doubt due to the radiant heat from the furnace above.

Miscellaneous Errors

Flue gas temperature, CO_2, and moisture in coal are additional errors that may affect the unaccounted-for losses. Bulletin 145 of the Bureau of Mines, showed the maximum error chargeable to this item to be approximately 25 deg. or about 0.6 per cent in efficiency—at least on the tests checked. A similar check on CO_2 indicated a maximum of about 0.4 per cent effect on efficiency.

While an error in coal moisture or analysis does not affect the Heat-Loss efficiency to as great an extent as the "weighed" efficiency, nevertheless it is one more item that goes to make up the unaccounted-for. A 1 per cent loss would affect Heat-Loss efficiency about 0.12 per cent and "weighed" about 0.8 per cent.

It would be very nice at this time to be able to add up all of the items we have covered and show them to equal the 3.5 per cent average unaccounted-for, but unfortunately this cannot be done since they would not all exist to the same degree on any one boiler test. If, however, we take the maximum losses of the items enumerated, the total will exceed 8.0 per cent, which is almost three times the figure we are looking for. Of course this would not exist on any one test, but it makes it a little easier to understand how the 3.5 per cent could be accounted for under normal conditions.

Shortly after Northeast Station went into service, expensive testing equipment was installed to permit the actual weighing of condensate from any turbine or the feedwater to any boiler, and a traveling weighing coal larry was installed to permit the accurate weighing of coal for test purposes. A series of about ninety 8-hr. weighed tests was then run to determine the "relative" value of Illinois, Missouri, Kansas, Oklahoma, and Arkansas coals when burned on the two types of fuel-burning equipment then installed. The Illinois series was used to check the guarantee; the others for comparative purposes. Since then more than 100 additional weighed tests have been run, and almost 80 per cent of all of the 190 tests were for "Comparative" purposes.

Obviously these tests represent considerable investment which could have been materially reduced if the weighing of water and coal had been eliminated, and with the knowledge available today on this subject this could have been done, particularly since the tests were for comparative purposes. Efficiencies could have been obtained by the Heat-Loss Method within a degree of accuracy that would compare with the actual water-weighed tests.

In the general instructions of the test code committee the statement has been made that: "The Heat-Loss Method requires special attention to all factors of importance in the evaluation of losses in relation to input." This of course is a very brief statement that covers considerable territory.

As far as the test code is concerned it is felt that sufficient information is presented to calculate the various losses if one cares to follow it.

Against the necessity for greater precaution in determining Heat-Loss efficiency or the possibility of a little less accuracy, must be balanced the fact that the Heat-Loss Method does not require a knowledge of either coal or water weights; hence no expensive equipment is needed for this purpose and of course it represents a greater conveinence and less possibility of hazard, since it does not disturb normal operation.

Notes on Combustion Calculations

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$(6.407 \times 32 \times 4.32) \div 100 = 8.85$ lb. air are required for perfect combustion.

There were, therefore, $12.27 - 8.85 = 3.42$ lb. of air supplied in excess of that chemically necessary. This would be $3.42 \div 8.85 \times 100 = 38.7$ per cent excess.

Obviously, this result might be based on nitrogen excess as follows:

9.4252 lb. N_2 supplied from air/lb. of coal.

From Table I, $24{,}218 \times 28 \div 100 = 6.78$ lb. N_2 required from air.

$9.4252 - 6.78 \div 6.78 \times 100 = 264.52 \div 6.78 =$ 38.7 per cent excess.

Solution: (c) The weight of dry flue gas per pound of coal fired.

100 mols of dry flue gas weigh

CO_2	12 mols	× 44 lb/mol =	528	lb.
CO	1 mol	× 28 lb/mol =	28	lb.
O_2	6 mols	× 32 lb/mol =	192	lb.
N_2	81 mols	× 28 lb/mol =	2268	lb.
Total	100 mols weigh		3016	lb. or 30.16 lb./mol

There are, therefore, $3016 \div 156 = 19.34$ lb. flue gas/lb. C in flue gas.

19.34×0.6495 lb. C in flue gas/lb. coal fired = 12.55 lb. dry flue gas per pound of coal fired.

Solution (d) The loss due to incomplete combustion, B.t.u./lb. coal as fired.

This refers to the loss due to part of the coal burning to CO instead of CO_2. When one pound of carbon is burned to CO_2, there are 14,600 B.t.u. released as compared to 4440 B.t.u. when burned to CO. Thus for every pound of carbon burned to CO, there are lost $14{,}600 - 4{,}440 = 10{,}160$ B.t.u.

The 100 mols of flue gas contained one mol of CO having 12 lb. of carbon per mol. Therefore:

(12 lb. C burned to CO/100 mols flue gas) ÷ (156 lb. C in flue gas/100 mols flue gas) = 0.6495 lb. C in flue gas/lb. coal fired = 0.0499 lb. C burned to CO/lb. of coal fired.

This represents a loss of $0.0499 \times 10{,}160 = 507$ B.t.u./lb. of coal fired.

Solution: (e) The loss due to unburned carbon, B.t.u./lb. of coal as fired.

From part (a) immediately above, it will be noted that 281.5 lb. of carbon were lost to the refuse and cinders per hour. This would be $281.5 \div 40{,}000 =$ 0.00702 lb. C lost/lb. of coal and would represent a loss of $0.00702 \times 14{,}600 = 102.5$ B.t.u./lb. of coal.

Electric Plant Adorns Swamp

Continued from Page 43

An adequate number of instruments have been installed to permit keeping very complete records and to permit checking the performance of any item of equipment. Steam flow meters and thermometers have been provided on each of the main boiler and turbine leads and on the auxiliary steam header. Venturi type water meters are installed in each boiler feed line and other meters in the evaporator feed line, plant service line, and similar locations. Thermometers are provided for obtaining the feedwater temperature at all points in the system; also ammeters for measuring the current flow to the motors driving the principal auxiliaries.

Coal Handling

One of the primary considerations when locating the new station was to provide coal for the plant by boat during the navigation season; a 500-ft. dock having been constructed especially for this purpose. To supply the plant during the winter months, a storage area for 20,000 tons of coal is available behind the dock. The plant is also served by its own siding connecting with the Pere Marquette Railroad. A Beaumont-Birch Co. drag scraper system is used to pile the coal in the storage area and to remove it for use in the plant. The drag scraper deposits the coal in a hopper pit adjacent to the building from which it is transported by belt conveyors and bucket elevator to the parabolic suspension bunker in front of the boilers. The hopper is also arranged to receive coal shipped by rail when necessary or desirable.

A magnetic pulley in the first belt conveyor removes all iron from the coal as it enters the building. After entering the building the coal handling system is totally enclosed in dust tight housings or chambers.

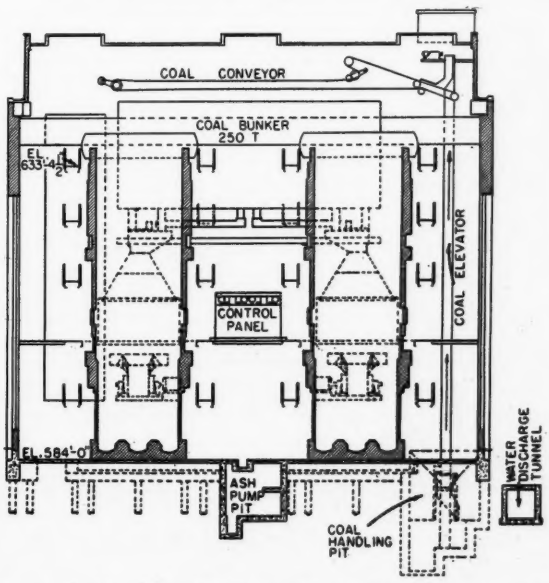


Fig. 6. Coal handling within the plant is shown by this cross section through the boiler room

The steel bunker is completely lined with gunite and the walls enclosing it are of the same material.

Coal from the bunker is continuously fed to each stoker hopper through a totally enclosed, automatic weighing and recording scale. The conveyors, scales, spouts, and stoker hoppers are dust tight to prevent filtration of dust laden air into the room. The whole coal handling system inside the building is kept under negative air pressure and ventilated by connecting its enclosure with the forced draft fan room.

Electrical Features

Current is generated at 4160 v. and distributed directly from the station switchboard at the same voltage. Formerly, all the city feeder circuits originated at the Fifth Street Station located about a mile away. Enough circuits have been transferred to the new plant to split the total load about evenly between the two, permitting the construction of the tie line between the new and old plants to be one-half that which would be required if all the feeder circuits originated at one plant. When the old plant is no longer required for standby service, the rest of the feeders will be transferred to the new plant.

Station auxiliaries are supplied with 440-v. current from duplicate banks of station service transformers. The transformers are located outside the building and have compound filled terminals to make them dust and weather tight. The distribution lines from the plant are carried underground in ducts to a distribution terminal tower at the edge of the plant property.

Being arranged for operation by the turbine house operator, the switchboard is a vertical unit set flush in the dividing wall between the turbine house and the switch house. The main switchgear is metal clad, draw-out type and is installed on the third floor of the switchhouse, which is at the same elevation as the turbine operating floor. The second floor contains feeder regulators for the primary lighting feeders, and on the first floor are installed generator neutral breakers, control storage battery and charger.

Distribution of power for auxiliaries is from a metal clad air circuit breaker switchboard mounted on the first floor of the turbo-generator building.

Cost and Construction

As a P.W.A. project, the station was constructed at a total cost of $1,543,553. Work on the site was started during the last week of December, 1938, and completed on schedule in June, 1940.

Work was divided into nine major contracts and three small ones, as follows:

Contract No. I—Construction of the railroad siding and road into the site, the dock, submerged parts of the cooling water intake and discharge structures, and all the foundation piling. Contractor: Lake States Engineering Co. Total cost $132,118.

Contract No. II-A—Furnishing and erecting the two turbine generators complete with all necessary instruments and gages and the spare exciter set. Contractor: Allis-Chalmers Mfg. Co. Total cost $340,000.

Contract No. II-B—Furnishing and erecting the two condensers complete with all necessary auxiliaries. Contractor: C. H. Wheeler Mfg. Co. Total cost $57,900.

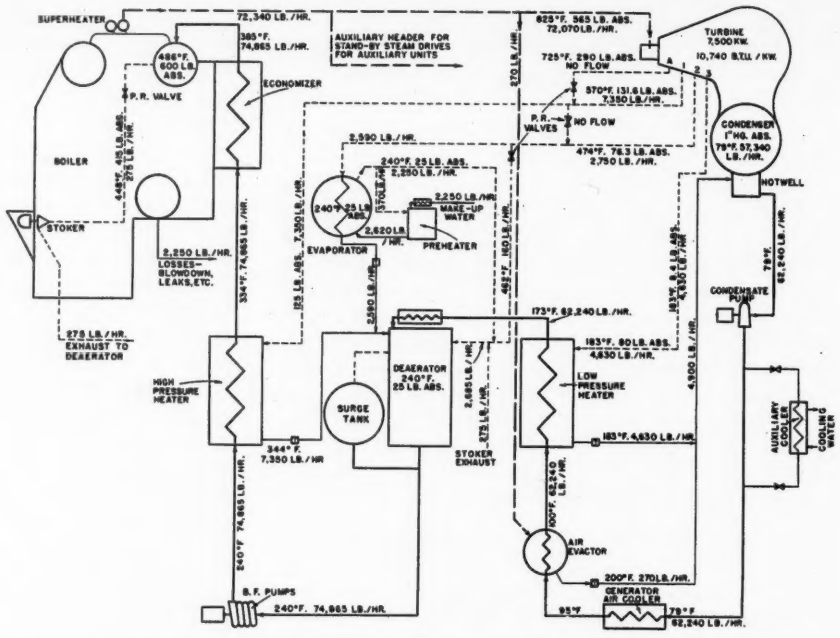


Fig. 7. Flow diagram showing heat balance of the plant

Contract No. II-C—Furnishing the four closed heaters delivered at the site. Contractor: Westinghouse Electric & Mfg. Co. Total cost $6,380.

Contract No. III—Furnishing the two steam generating units erected on their foundations complete with all auxiliaries including stokers, fans, ash handling system, stacks, breeching and ducts, control and instruments, meters and gages. Contractor: Edge Moor Iron Works. Total cost $224,552.

Contract No. IV—Construction of the building proper including all incidental structural work such as the cooling water tunnels and intake superstructures, extension of a trunk outfall sewer, underground electrical ducts, and landscaping of the grounds. Contractor: Strom Construction Co. Total cost $321,372.

Contract No. V—Furnishing and installing all the electric wiring, switchboard, switchgear and related equipment including distribution circuits to the terminal tower. Contractor: Dearborn Electrical Construction Co. Total cost $144,816.

Contract No. VI—Furnishing and installing all piping and insulation, complete with all necessary flow meters, valves and specialties and including the deaerator, evaporator, boiler feed pumps, chlorinating equipment, all service water pump and tanks, and similar related equipment. Contractor: Johnson, Larsen & Co. Total cost, $125,676.

Contract No. VII—Furnishing and erecting the coal handling system complete from the drag line on the dock to the stoker hoppers except for the suspended bunker which was included in the building contract. Contractor: General Conveyors Corp. Total cost, $32,106.

Contract No. VIII—Furnishing the office furniture, files, lockers, etc. Contractor: Fris Book Store, Holland, Michigan. Total cost, $1,735.

Contract No. IX—Constructing the tie line between the old and new plants and transferring four of the feeder circuits over to the new plant. Contractor: Clifton Engineering Co., Zeeland, Michigan. Total cost, $10,345.

Contract No. X—Paving the coal storage area with concrete. Contractor: Lee M. Perry, Beaverton, Michigan. Total cost, $11,935.

The total construction cost was $1,408,935. In addition to this the total cost of the site, engineering, legal and preliminary make a total of $1,543,553 for the complete project, or $102.90 per kw. of installed capacity.

Personnel

Hamilton & Weeber, Grand Rapids, Michigan, were the consulting engineers on the work and Giffels & Vallet, Inc., Detroit, associate engineers. The operation of the municipal power system is under the direct control of the Board of Public Works, a five man non-political body serving without remuneration.

In its Annual Report, Federal Power Commission gives as major activities: Surveys of and passing on permits and licenses for water power projects, of which 102 were received, 14 being for licenses for major projects of 992,679 hp., 6 for permits of 809,187 hp., the balance for minor projects.

Regulation of wholesale rates for power and natural gas in interstate commerce, in which 44 proceedings were involved.

Prescribing methods of accounting, for natural gas and electric utility companies, to bring them onto a uniform system.

Surveys of power requirements of the country, especially in case of emergency, and recommendations to the Secretary of War as to installation of generating facilities needed.

Reports on rates for electric service in all parts of the country, classified according to population of communities served.

Reports on finances, operation and output of all privately-owned electric utilities.

Supervision of mergers, sales and security issues of utilities to protect public interest.

Principal Equipment in Holland's New Power Plant

Steam Generating Units

BOILERS: 2; Edge Moor Iron Works; 90,000 lb. steam per hr. normal rating, 112,500 lb. maximum, 3 drum bent tube, 600 lb. ga. design pressure, with 7832 sq. ft. heating surface. Furnace water cooled, four walls with 1526 sq. ft. heating surface and 3 ft. belt of Bernitz Nygaard Carborundum Armor, volume 4175 cu. ft.

ECONOMIZERS: 2; Edge Moor Iron Works; 2930 sq. ft. surface of 2 in. dia., No. 7 ga. bare seamless steel tube, horizontal hairpin loop, counterflow arrangement, 700 lb. pressure.

SUPERHEATERS: 2; Foster Wheeler Corp.; 2400 sq. ft. surface of 2 in. No. 8 ga. seamless steel bare tube, two pass, four loop, pendant type. High temperature section of alloy steel.

STOKERS: 2; American Engineering Co.; 8 retort, inclined, underfeed, double roll clinker grinder type with 208 sq. ft. projected area. Terry turbine and Allis-Chalmers motors for drives.

Draft Equipment

INDUCED DRAFT FANS: 2; American Blower Corp.; 80,700 c.f.m. at 650 deg. F. forward curved blade fans. Main drive Allis-Chalmers 125 hp. 4 speed induction motor; auxiliary drive Moore 122 hp. noncondensing geared steam turbine. Couplings, Morse Kelpo free wheeling clutch type (1 each drive).

FORCED DRAFT FANS: 2; American Blower Corp.; 36,400 c.f.m. at 80 deg. F. backward curved blade, non-overloading type with inlet vane vortex damper. Drive, Allis-Chalmers 60 hp., 4 speed induction motor. Couplings, Falk flexible coupling.

Boiler Control and Trim

COMBUSTION CONTROL: 2; Hays Corp.; electrically operated completely automatic control systems.

FEEDWATER CONTROL: 2; Northern Equipment Co.; Copes regulators and excess pressure control valves.

SOOT BLOWERS: Diamond Power Specialty Corp.

WATER COLUMNS: Reliance Gauge Column Co.; inclined flat glass type (2 per boiler).

SAFETY VALVES: Consolidated Ashcroft-Hancock Co.

BLOWOFF VALVES: The Edward Valve & Mfg. Co., Inc.

FEEDWATER VALVES: The Edward Valve & Mfg. Co., Inc.

Ash Handling

ASH PITS: 2; Allen-Sherman-Hoff Co.; air tight, cast-iron hoppers with hydraulic sluicing equipment.

ASH PUMP: 1; Allen-Sherman-Hoff Co.; horizontal, single stage, center suction ash pump. Drive, General Electric 50 hp., 1800 r.p.m. syn. speed motor through V-belts.

Coal Handling Equipment

DRAG LINE: Beaumont-Birch Co.; 30 tons per hr. capacity at 200 ft. haul drag line system.

BUCKET ELEVATOR: General Conveyors Corp.; 45 tons per hr. capacity.

FEEDER AND DISTRIBUTING CONVEYORS: General Conveyors Corp.; 5 tons per hr. capacity.

AUTOMATIC SCALES: 2; Richardson Scale Co.; dust tight automatic weighing and recording scales.

BUNKER: Steel Fabricating Co. of Muskegon, Mich.; suspension type bunker.

Electric Generating Equipment

TURBINE GENERATORS: 2; Allis-Chalmers Mfg. Co.; condensing, 3600 r.p.m., 7500 kw., 60 cycle, 3 phase 2400/4160 v. unit with direct connected 125 v. kw. exciter. Steam conditions 550 lb. ga., 825 deg. F. total temperature, and 1 in. Hg. back pressure.

GENERATOR AIR COOLERS: 2; Griscom-Russell Co.; 4420 sq. ft. surface.

SURFACE CONDENSERS: 2; C. H. Wheeler Mfg. Co.; two pass with 8500 sq. ft. surface of ⅞ in. O.D., No. 18 B.W.G. Admiralty metal tubes, 18 ft. effective length and with deaerating hot well.

COOLING WATER PUMPS: 4; C. H. Wheeler Mfg. Co.; 4950 g.p.m. 720 r.p.m. horizontal centrifugal circulating pumps. Drive, General Electric Co. 40 hp. 720 r.p.m. direct connected induction motors.

CONDENSATE PUMPS: 4; C. H. Wheeler Mfg. Co.; 200 g.p.m., 1750 r.p.m. two stage centrifugal pumps. Drive, General Electric Co., 20 hp., 1800 r.p.m. induction motors.

AIR PUMPS: 2; C. H. Wheeler Mfg. Co.; dual, two-stage steam jet air evactors with inter-after surface condensers.

SPARE EXCITER: 1; Allis-Chalmers Mfg. Co.; non-condensing, 3600 r.p.m. impulse, turbine direct connected to 50 kw. 125 v.d.c. exciter. Steam conditions 550 lb. ga., 825 deg. F. total temperature.

Feedwater Equipment

BOILER FEED PUMPS: 3; DeLaval Steam Turbine Co.; 6 stage, 148 g.p.m. (70,000 lb./hr.) at 240 deg. F. and 750 lb. ga. centrifugal pumps. Drives, 2 Allis-Chalmers Mfg. Co. 125 hp. direct connected induction motors; 1 DeLaval single stage, non-condensing steam turbine.

HIGH PRESSURE HEATERS: 2; Westinghouse Elec. & Mfg. Co.; horizontal, four pass, closed heaters with 238 sq. ft. tube surface. Design pressures: tubes 800 lb. per sq. in., shell 150 lb. per sq. in.

LOW PRESSURE HEATERS: 2; Westinghouse Elec. & Mfg. Co.; horizontal, four pass, closed heaters with 245 sq. ft. tube surface. Design pressures: tubes 150 lb. per sq. in., shell 150 lb. per sq. in.

DEAERATING HEATER: 1; Elliott Co.; vertical shell direct contact heater with total delivery capacity of 200,000 lb. per hr. at 240 deg. F.

EVAPORATOR FOR MAKE-UP: 1; Griscom-Russell Co.; horizontal shell submerged coil evaporator with gross capacity of 7300 lb. steam per hr. at 10 lb. ga. Design pressures: tubes 250 lb. per sq. in., shell 50 lb. per sq. in.

EVAPORATOR PREHEATER: 1; Elliott Co.; vertical shell direct contact deaerating heater with delivery capacity of 7300 lb. per hr. at 10 lb. ga.

Piping, Miscellaneous Pumps, Meters, Etc.

NON-RETURN VALVES: 2; The Edward Valve & Mfg. Co., Inc., 8 in. series 60.

MOTOR-OPERATED VALVES: 5; Crane Co.; 8 in. welded.

RELIEF VALVES: Atwood & Morrill Co.

OIL CHECK VALVES: Atwood & Morrill Co.

STANDARD VALVES AND PIPING: Crane Co.

PIPE COVERING (Insulation): Keasbey & Mattison Co.

STEAM FLOW METERS: Cochrane Corp.; electric meter.

FEEDWATER VENTURI METERS: Cochrane Corp.

SERVICE WATER PUMPS: 2; American-Marsh Pumps, Inc.; 80 g.p.m., 141 ft. head single stage centrifugal pump with Barton primer and Kraissl vacuum pump. Drive, Howell 7½ hp., 1750 r.p.m. direct connected motor.

ASH SLUICING PUMP: 1; American-Marsh Pumps, Inc.; 450 g.p.m., 278 ft. head single stage centrifugal pump with Barton primer and Kraissl vacuum pump. Drive, Howell 40 hp., 3500 r.p.m. direct connected motor.

ASH MAKE-UP WATER PUMP: 1; American-Marsh Pumps, Inc.; 600 g.p.m., 81 ft. head single stage centrifugal pump with Barton primer and Kraissl vacuum pump. Drive, Howell 20 hp., 1750 r.p.m. direct connected motor.

HEATING RETURNS UNIT: American-Marsh Pump, Inc. twin automatic float controlled pump and receiver unit.

UNIT HEATERS: Dunham Co.; multiblade type.

Miscellaneous Equipment

WATER INTAKE SCREENS: 2; Link-Belt Co.; vertical traveling screen 5 ft. x 15 ft. approx. Drive, 3 hp., 1750 r.p.m. motor and Link-Belt speed reducer.

CHLORINATOR: Formhals.

CRANE: 1; Shaw-Box Crane & Hoist Co.; 30 ton with 5 ton auxiliary hoist.

AIR COMPRESSOR: Chicago Pneumatic Tool Co.

SWITCHBOARD: Allis-Chalmers Mfg. Co.

SWITCHGEAR: Allis-Chalmers Mfg. Co.

TRANSFORMERS: Moloney Electric Co.

AIR CIRCUIT BREAKERS: Roller Smith Co.

CONTROL BATTERY: Gould Storage Battery Corp.

POWER AND LIGHTING PANELS: Wm. Wurdack Electric Co.

Miscellaneous Building Materials

ELEVATOR: Detroit Elevator Co.

STRUCTURAL STEEL: Steel Fabricating Co.

REINFORCING STEEL: Calumet Steel Co.

ORNAMENTAL AND MISC. IRON: Haven-Busch Co.

GRATING: Blaw-Knox Co.

WINDOW SASH: Hope Windows, Inc.

ROOFING: Glendon A. Richards Co.

ROOF DECK (Haydite Tile): Federal American Cement Tile Co.

BRICK: Belden-Stark Brick Co.

TILE: Belden-Stark Brick Co.

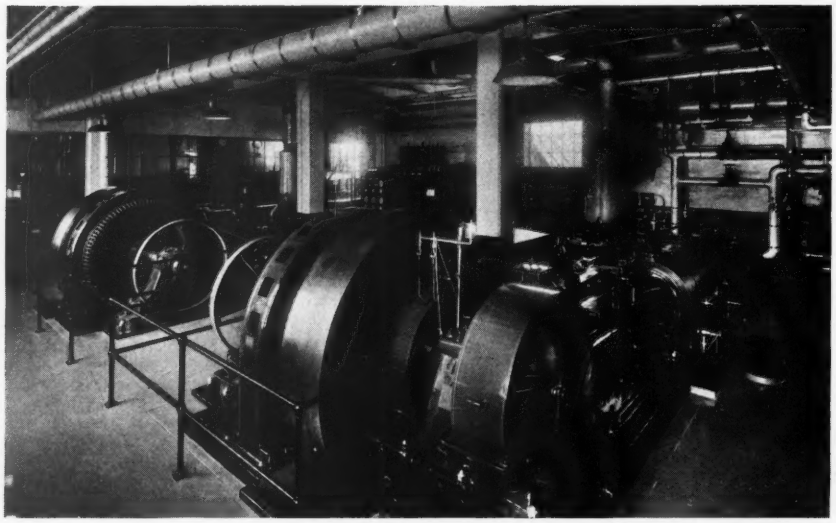
STONE TRIM: Adam Groth Co.

TERRAZZO WORK: John B. Rossi Co.

ALUMINUM DOORS: Nietringhaus, Inc.

ROLLER CURTAIN DOORS: R. C. Mahon Co.

LANDSCAPING: I. E. Ilgenfritz Sons Co.



Every power plant has dozens of points where lubrication is applied. All of these need care and attention.

"Plenty Of Oil" Not Enough

By JOHN E. HYLER

THE MERE use of "plenty of oil and grease" by no means fulfills the requirements of adequate lubrication. Plenty of oil and grease is only one of the requirements, and there are some cases and places where too much oil is a liability. In the case of ball and roller bearings for example, where there are open spaces of considerable size, if too much lubricant is present there will be churning action which generates heat. If follows that lubricant must be admitted to such a bearing by wicking or by some similar means that will supply it in small but continuous amount.

It is highly important that oil be kept in the bearings of equipment, but it is just as important that dust be kept out. Any foreign matter that gets into a bearing is going to have an abrasive action. From this, it follows that the method of storing lubricant is important. It is as important that a lubricant storage container be dirt and dust tight as it is that this condition should obtain in a bearing.

Real high-quality oil applied in the proper amount and the proper manner to the particular place for which it is adapted is always economy oil, regardless of its first cost. No lubricant must be judged on its first-cost basis. The cost of oils and greases used will be that cost represented by efficient and long operation, or by the opposite, as the case may be. The man who buys quality lubricant suited to his purpose buys machinery performance.

The various aspects arising in the lubrication field today are multitudinous. The subject is a science in itself, and some who deal in lubricants exclusively have in their employ lubrication engineers who devote their entire time to the subject. The knowledge they gain is cumulative, and for that reason problems of lubrication are better and better understood. Today, the purchaser of lubricants or of lubricating devices finds a great array of them waiting for his selection.

Compressed Air Stream Lubrication

One aspect of equipment lubrication that has commanded considerable attention of late is the lubrication of equipment depending upon compressed air as a drive, or equipment through which compressed air must pass, for example, air valves. Air tools of various portable types will operate to much better advantage when they receive a certain amount of lubricant in the air stream. The method of supplying this oil, as used by some, is simply to place in the compressed air line a specially-designed lubricator. This device is adjustable, so that any pre-determined or desired amount of lubricant may be fed into the air stream continually. The oil is well distributed through the air and reaches the tools as a mist or fog, keeping an oil film on the moving parts to protect them. Such air line lubricators are often provided with a sight feed oil container so that one can readily see when the oil supply is about to become exhausted.

Moisture and foreign matter in the air stream are just as hard on air tools as the proper application of oil to their moving parts is protective, as a consequence certain builders of air line lubricators have made them up in tandem with an air line separator. The separator is set so that it receives the air just ahead of the lubricator, and the moisture, scale or dirt that may be

contained in the air is thus removed just before it reaches the lubricator. Lubricators of this nature are well adapted for use in compressed air lines leading to air-operated cylinders or to air control valves, as well as to various types of pneumatic tools.

Mechanical methods of delivering lubricant from some central point or reservoir to all the bearings on a machine or piece of equipment are of value not only from the standpoint of time-saving, but also from that of insurance. Where such systems are properly applied, there is assurance that every bearing is receiving adequate lubrication; in fact, in most cases, such systems provide for measuring the lubricant to each bearing while the machine is in operation. The cost of hand oiling, over against such a system as this, is not merely the cost of the time of the man or men doing the oiling; it is that cost plus the cost of that much "outage" time on the equipment itself. The cost of hand lubricating, in such cases, increases directly as the value of the piece of equipment involved, or as its outage time may affect adversely the advance of production.

Keeping Grit Out of Bearings

Never by any means allow an oil cup to remain open where dust and grit are present. Even though only a small amount of abrasive matter may find its way into a bearing in this manner, the result may be serious. There is no excuse for open oil holes; oil and grease cups in great array are easily obtained.

With open types of bearings where oil or grease cups cannot be applied satisfactorily, it is necessary to apply some sort of covering that will filter out the grit as it admits the oil. Wicking is better by far than leaving a bearing open, but some prefer a piece of felt. A piece of felt can be taken out of the bearing cup and flushed out with a bath of clean warm oil. Felt retains considerable oil and feeds it to the bearing gradually, and is therefore good material to serve as a safeguard in the case of bearings that are liable to be neglected.

Gradual application of a lubricant is usually the nearest approach to a mechanically measured and applied amount that can be found, but it can never be considered as good a mechanical method. It is possible to arrange for gravitational feed of oil to a bearing, and still have that oil carefully measured. One gravity lubricator of the measuring type has a spiral-shaped metering pin, which is set at the factory to deliver a certain amount of lubricant. The amount may be one drop of oil per minute, or it may vary on either side of that amount as desired in the particular case. This is a sight-feed device, allowing one to observe the amount of oil in reserve at all times, and to replenish the supply as may become necessary.

Pick-up Types of Lubrication

Bearings designed in a manner as to allow oil to be automatically picked up or raised from a reservoir housed just beneath the bearing, to circulate over the bearing surfaces, and the excess to return to the bearing reservoir continually, are suitable in a great many cases, but they are best adapted for locations where temperature variations are not severe, and they call for a carefully determined type of lubricant. If the lubricant used in the reservoir of a ring-oiling bearing, for instance, is too heavy or viscous, there will be such a heavy viscosity drag on the ring that it may stall on the journal and fail to deliver oil to the journal surface properly. The opposite effect of having an oil that is too light for the prescribed duty is equally bad, for as the oil decreases in body, less of it tends to cling to the oil ring and less is delivered to the journal surface. If the amount lifted is inadequate, the bearing begins to rise in temperature. This further lightens the consistency of the oil in the reservoir, and thus the trouble tends to build up until a badly heated bearing is on hand. Well-designed ring-oiling bearings, however, when supplied with an oil suited to their purpose, are highly effective, and take care of the oiling question automatically.

The pick-up, re-circulating type of bearing is not limited to the ring oiling type, for there have been many worthy variations, some of which are positive in their pick-up action. Such a case is found in a bearing which recently came to the attention of the writer, in which an inner and outer race are arranged to work together, without the incorporation of any rolling elements such as balls or rollers. The two races are separated only by an oil film derived from the pick-up feature of the bearing as mentioned. The inner race is so designed as to dip into an oil reservoir below the bearing, and has a series of closely-spaced holes arranged in it to serve as oil pick-ups. These holes fill up with oil. Slots lead from these holes to the face of the race, the slots extending radially outward. Centrifugal force drives the oil through the slots to the race, where the film for separation of the two races is formed.

Keeping Metal Chips Out of Lubricant

One of the most damaging things that can possibly occur in a system where there is a circulation of lubricant, no doubt, is the breaking off of tiny bits or chips of metal from any cause whatever, have them find their way into the reservoir, and somehow be carried out with the supply of lubricant en route to the bearings again. Such chips finding their way into bearings or working parts, can do a lot of cutting in short order. Most of us are in some measure acquainted with the fact that oil filters are provided for application to lubricant circulating systems in order that this thing may be avoided, and it is well to use such filters at every point where they are indicated as necessary.

On the other hand, there are probably a great many who do not know that another convenient factor has been brought to bear on this problem, and that is to accelerate the settling of such bits of metal out of suspension in the oil, and to entrap and hold them once they have been precipitated. Magnetism is the answer to this, and it has been employed to very good advantage. In the bottom of engine crankcases where splash lubrication is being used, or in any lubrication reservoir where a drain is provided at the bottom, instead of using an ordinary drain plug, a plug with a magnetic core is installed. Such a plug will not only attract ferrous chips, drawing them to itself, but it will steadily hold them until the next time the plug is removed. Such plugs may be had in any reasonable size. They should not be regarded as a substitute for the filter, however, but as supplementary to it.

MILLERS FORD-
3 Years of High Temperature Operation

Part II*. Continuation of the detailed operating experience of a pioneer 1200 lb., 900 deg. F. top at Millers Ford Station. Water level, combustion and temperature control, pulverizers, fans, boiler-feed system, valves and piping, coal handling and tank protection.

By R. D. GILLESPIE
Chief Engineer of Power Plants
The Dayton Power & Light Co.
Dayton, Ohio.

FEEDWATER control originally installed was actuated solely by the drum level. This operated very well at a constant boiler output, but sudden change in output produced violent swings in feedwater flow and wide variations in drum levels. Later developments indicated that the control may not have been entirely responsible for this unstable condition. A three-element control was tried, and while it could not be said that the regulation was good, it was definitely better than it had been. Since the economizer change mentioned earlier the control has been satisfactory and Fig. 8 shows the present level variation during a typical 24 hr. period.

Steam temperature is regulated by a gas damper system under automatic control and has given an excellent account of itself. The control is set up to maintain the exhaust temperature from the high pressure turbine at 575 deg. F. and at the same time prevent the throttle steam temperature from exceeding 900 deg. F. For heavy loads the throttle temperature will be held constantly at 900 deg. F.; for light loads this temperature is reduced to keep the exhaust temperature at or under 575 deg. F. The chart in Fig. 9 shows the effect of exhaust steam temperature correction on the normal superheated steam temperature control.

*Part I appeared on p. 38 of the June Issue.

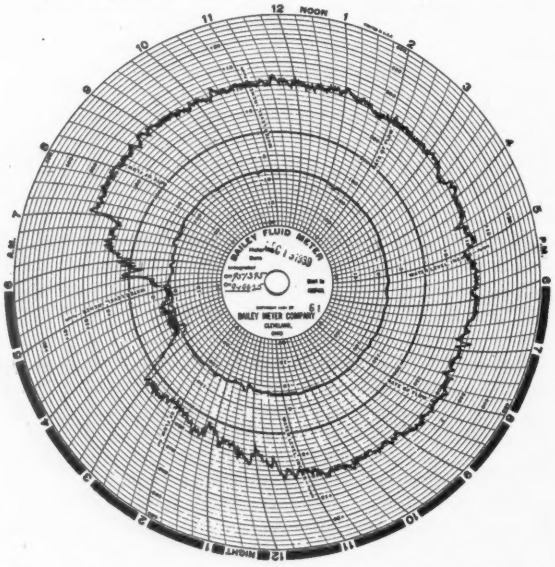


Fig. 8. Early difficulties with water level control have been eliminated and this typical 24 hr. chart shows a maximum variation of about 2 in.

Changes in superheat temperature are effected by positioning the economizer damper. The drive unit for the economizer damper gets its impulse from the control on its respective boiler and from the temperature controller on the turbine exhaust. A selector switch is provided for either manual or automatic control. When difficulty is experienced with excessive superheat due to an accumulation of slag, the control opens the economizer dampers wide and further temperature reduction must be obtained by throttling the superheater dampers manually for the ability to regulate superheat during an abnormal condition lies beyond the range of the control.

No alteration to the air loaded, electrically operated combustion control was made until February, 1939, when the original aluminum open type manometer was replaced with brass because the sealing fluid, acetylene tetrabromide (sp.g. 3.9), caused deterioration of the aluminum. At the same time a thin layer of glycerine was added as a seal because of the corrosive action of the gas released by the tetrabromide. After several months sluggish action developed on all controllers. Examination revealed a heavy sludge, formed by the glycerine and acetylene tetrabromide, adhering to the bells, and also that the brass had crystallized and could easily be broken with the fingers. In February, 1939, closed manometers, filled with a lighter, non-corrosive liquid were installed, and these have eliminated all difficulty from this source.

Pulverizers

Pulverizer performance has been very good, only two maintenance problems were encountered and both have been solved. The original feeder plates, of steel made in one piece and faced with carborundum, involved considerable labor to remove the entire plate for replacement. These have been changed to a sectional type of plate with carborundum cast in the steel. These wear much longer than the former type and may be replaced without dismantling that part of the mill.

Cap screws with which the plows were fastened to the moving element failed under shear and the plows were redesigned so that instead of being fastened to the upper grinding ring, the upper part of the plow now fits in a recess formed by welding three pieces of keystock to the driving spider. Cap screws are still used to hold the plow in place, but the stress is borne by the keystock.

After pulverizing more than 80,000 t. of coal, the balls and grinding rings were removed from one of the mills. The manufacturer recommended the old grinding rings be reinstalled with balls slightly larger than the ones removed. When this is done, estimates based on the wear that has already occurred place the life of the rings at about

150,000 t. V-belts have been replaced on three of the six mills.

Average fineness of the pulverized coal leaving all mills, from the time of installation to date, is 78.6 per cent through a 200 mesh sieve. Mill power consumption, including feeder motor and weighing scale motor, has averaged about 18.0 kw-hr. per t. of coal pulverized. The West Virginia coal used has a grindability of about 50.

Coal pipes between mills and burners have required no maintenance. One burner had to be re-

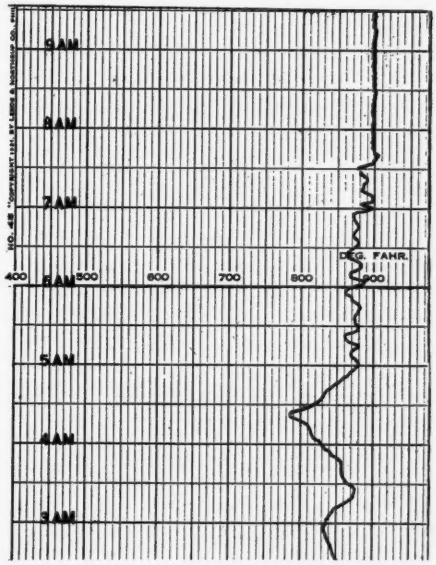


Fig. 9. Steam temperature chart showing both light and heavy load operation of the automatic temperature controller actuating the economizer bypass. Normally the temperature is held at 900 deg. F. the throttle as shown at the left but at light loads the temperature is reduced so as to keep the top turbine exhaust below 575 deg. F.

paired due to coking, caused by failure to sweep out the mill and pipes when shutting down. Present operating procedure requires that this be done and no further trouble has been encountered.

Draft Fans and Air Heaters

Pressure drops in the forced draft ducts ran higher than expected and when it was discovered that maximum boiler output could not be obtained because of a lack of forced draft fan capacity, larger rotors were installed in each fan. The only other cause for concern on these fans was a forced outage resulting from an expansion joint failure at the discharge of the fan. Improved type joints on both fans eliminated this source of possible trouble.

Some erosion occurred on the tips of the induced draft fan blades, particularly near the center ring of the rotor. New rotors with steel strips welded to the leading side of the blades adjacent to the center ring and ribs formed by welding beads running parallel to the tips were installed. When the fans are overhauled, these ribs are built up in spots where needed but erosion at the center has ceased.

Hydraulic couplings used on both forced and induced draft fans have operated satisfactorily and the same type of coupling of slightly different design will be used on the new installation. Maintenance has been negligible except for the coupling on one of the forced draft fans, which has failed twice due to the thrust bearing. Originally this was located in the coupling but was relocated on the outboard end of the motor. This second outage occurred almost 2 yr. ago and it may be assumed that this is just one more wrinkle that has been ironed out.

External surfaces of the tubular air heaters are kept quite clean by six rotating soot blowers on each heater. Some external corrosion is evident on the upper row of tubes extending back about 2 ft. from the inlet ends, with the length of the affected portion decreasing on each successive lower row. The seventh row from the top shows no corrosion at all. The condition is not serious and it is not believed that tube replacements will be necessary for a long time.

Some difficulty was experienced with arcing and eventual burning off of the electrodes on the electrostatic precipitators. This was corrected by changes in the design of the electrode shrouds and rapping mechanism. The efficiency of the precipitators was also increased by placing baffle plates at the inlet and outlet edges of the frames; by welding perforated plates to the curtain rods; and by adding vertical baffle plates in each hopper under the cells.

Boiler Feed System

The earliest and most frequent source of trouble with the secondary boiler feed pumps was the packing sleeves which developed cracks probably caused by the hardness of the metal. These were replaced with softer sleeves chromium plated on the wearing side and this apparently remedied the difficulty. Erosion of the pump casing occurred several times at the high pressure breakdown bushing between the last stage and the equalizing chamber which reduces the pressure on the packing at the high pressure end. This was improved by a wider bushing which offered more bearing surface to the pump casing. Various packing was tried until the metallic packing which is now being used successfully was adopted.

Carryover was encountered in the initial operation of the double effect evaporators, due largely to makeup water, high in suspended matter, from an overloaded hot process lime and soda softener. Lime deposits fouled the steam scrubbers and gill separators. A new, larger capacity softener now delivers makeup free of suspended matter. Other improvements consisted of placing a hood over the scrubber box to eliminate flooding the gill steam separator chamber; and the installation of a surface blow-down line across the evaporator shell. This, together with weekly cracking, keeps the surfaces clean and free of scale. Hagan phosphate and tannin is fed intermittently to the suction of the evaporator feed pumps. Carbon dioxide in the second effect coil corroded the copper float in the discharge trap severely and a stainless steel float was substituted. The evaporators normally operate at about 24,000 lb. per hr. output. With a 10 per cent blow down, the evaporator vapor contains less than 1.5 p.p.m. of solids.

The two 750,000 lb. per hr. deaerating heaters will deliver oxygen-free water when supplied with sufficient auxiliary exhaust steam at about 1.5 lb. ga., but it has been difficult to obtain good regulation of this pressure, especially with varying flows through the deaerating heater. This condition was alleviated somewhat by installing a diaphragm operated valve controlled by the auxiliary exhaust pressure to admit live steam to the exhaust steam line just before it enters the deaerator. This problem has not been entirely solved as yet, however, since traces of oxygen are found in the deaerator effluent at times. Checks at the same time show that this oxygen is not present in the feedwater when it leaves the feedwater heater and thus it is not an economizer problem.

The crossover feedwater heater is located on the discharge side of the secondary boiler feed pumps and receives most of its steam from the exhaust of the high pressure steam turbines driving these pumps. Internal cleaning has been necessary on two occasions, due to fouling caused by the feedwater treatment. The deposit removed by one cleaning was largely calcium orthophosphate and the other time it was iron oxide occluded in oil. Before these cleanings, the outlet temperature had dropped from 400 to 385 deg. F. Some tube leakage occurred in the heater, requiring the rerolling of about two-thirds of the tubes. Two tubes have failed at the tube sheets, one eroding two adjacent tubes so that all three had to be replaced, the other cutting the tube sheet so the tube was removed and the hole plugged.

Leaks at the inlet and outlet water connections have been attributed to strains set up by the short radius bends in the piping at these points. While this has given very little trouble it will be corrected during the installation of No. 8 Unit. The narrow fabric gaskets sealing the steam space at both ends of the heater and which must be split for replacement without removing the tube bundle, has leaked at times.

On No. 7 unit the crossover heater drains passed through a 125 and 20 lb. flash tank to the deaerator, with the flash condensed in the evaporator condenser. After No. 8 is in service the drains from both crossover heaters will pass through a drip heat exchanger as shown by Fig. 10 with the flow regulated by a level controller to keep the drop heat exchanger tubes submerged at all times.

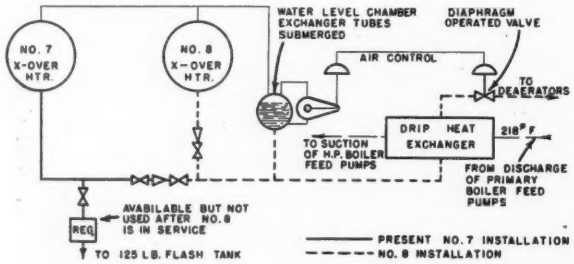

NO. 7 X-OVER HTR.
NO. 8 X-OVER HTR.
WATER LEVEL CHAMBER EXCHANGER TUBES SUBMERGED
DIAPHRAGM OPERATED VALVE
AIR CONTROL
TO DEAERATORS
DRIP HEAT EXCHANGER
218° F
TO SUCTION OF H.P. BOILER FEED PUMPS
FROM DISCHARGE OF PRIMARY BOILER FEED PUMPS
REQ
AVABILABLE BUT NOT USED AFTER NO. 8 IS IN SERVICE
TO 125 LB. FLASH TANK
PRESENT NO. 7 INSTALLATION
NO. 8 INSTALLATION

Fig. 10. When Unit No. 8 is in service the crossover heater drains will be changed as shown above. The complete flow diagram is shown by Fig. 3

The original reducing valve, designed as an emergency bypass, was too lightly constructed for the continuous service encountered during the first few months and was replaced by a heavier valve. While the reducing valve and desuperheater are equipped for either automatic or manual operation by remote controls from the boiler panel, automatic control is not used, because the fireman can place the equipment in operation in a matter of seconds. Excessive pressure drop in the line from the boiler feed pumps to the desuperheater water reservoir, at first, made it difficult to control the level of the water in the reservoir but a larger line was the answer and the automatic level control now functions perfectly. Bolts in the joint connecting the desuperheater venturi nozzle with the main steam line, were replaced with ones having a greater tensile strength.

Most of the valve troubles occurred during the first few months of operation due mostly to carryover from the boiler, and was especially troublesome in the case of the boiler non-return valves. The gate valves of both boiler leads froze due to being closed too tightly while hot and this was remedied by placing stop rings on all valve stems. Most of the large valves are now motor operated.

All high pressure main steam and water lines are welded, and no welds have failed or developed leaks. Welding will be even more extensive on the new unit, for instance the 10 in. downcomers from the present boiler drums have flanged joints just below the drum. An outage was caused by a gasket leak at one of these joints. These will be welded joints on the new boilers.

Coal for the high pressure boilers is delivered to a track hopper from which point it is raised to belt conveyors by a 150 t.p.h. skip hoist of the single-bucket, counterweighted type. Bucket cables have averaged about 260,000 t. of coal handled between replacements and counterweight cables about 375,000 t. The cross conveyor and distributing conveyor belts have given no trouble after handling one million tons of coal. Practically no maintenance other than replacement of cables has been required on any of this equipment.

The 100,000 gal. high head well water tank and the two 70,000 gal. hotwell tanks are protected from corrosion by the cathodic method. The chief chemist has conducted exhaustive tests on the protective equipment and by improving the electrode arrangement and experimenting with various current densities has reduced the corrosion rate from 50 to 15 per cent of the unprotected value. These experiments will be continued with the expectation of achieving still further improvements.

The reader should not interpret the foregoing recitation of troubles and their solutions as indicative that bright spots are in the minority for that is not the case. If everything works according to schedule, a few sentences suffice. The intention here was to relate our experiences, both good and bad, with the hope that others may profit by them, and that the example set may lead to a more candid discussion of operating experiences to the ultimate good of the industry.

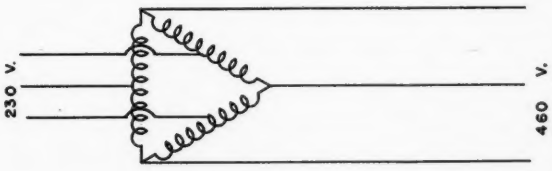
A cursory inspection of the simple transformer diagram shown on this page will reveal nothing unusual. It would seem quite logical that if the center point of each of the three windings is tapped as shown, the voltage across the leads would show just half the full voltage of the transformers. But as the author points out, though logical enough on paper, in practice this is not necessarily true. Quite often the voltage across the left hand leads will be found much lower than half the full voltage and they will not necessarily be alike. Mr. Friedman's point is well taken and his suggestions should be of value to anybody operating or concerned with three phase transformers.

Simultaneous Loading Of Transformers

By VICTOR N. FRIEDMAN

IT HAS BEEN pretty well established, mathematically, that two and two equal four and 230 and 230 equal 460 but these statements do not always hold. How come? Well, read on.

It is sometimes desirable to obtain two different voltages simultaneously from the same bank of transformers. If three ordinary transformers of 230 and 460 v. secondary ratings are connected in double delta shown in the accompanying sketch and loads applied



simultaneously to the two circuits it will be found that the 460 v., three-phase circuit will maintain its rated voltage, practically, while the 130 v., three-phase circuit will show a variation in the three voltages and all of them being lower than 230. These values will depend on the respective loads and power factors on the two circuits.

In a recent installation a 230 v., three-phase source was required for the operation of rotary converters and a 460 v., three phase circuit was also required for certain motors. It was desirable that the same bank of transformers be used as the source of the two secondary circuits as the present direct current motors will ultimately be changed to alternating current at 460 v. thus eliminating the need of the rotary converters and the 230 v. source.

Three wire operation on transformers rated 230-460 v., low voltage, is not standard according to NEMA standardization rules. However, if the windings of the transformers are properly interlaced, simultaneous 230- and 460-v. loads may be applied with good voltage regulation on both circuits.

In this case, transformers were ordered with interlaced windings and low reactance in order to assure good voltage regulation. The transformer manufacturer overlooked that part of the specifications applying to double simultaneous loading and supplied standard transformers. When a 460-v. load was applied a normal and balanced voltage was obtained. When the 230-v. rotary load was applied the direct current voltage was low and oscillating. The 460-v. circuit maintained its normal and balanced voltage. The connections of the rotary converters were checked and found correct. When a voltmeter was connected to the secondary terminals of the transformers the trouble was located. The full 460 v. were obtained across each full secondary winding but the voltages across the half windings varied from 190 to 218. Thus it was evident the transformer manufacturer had overlooked a vital part of the specifications.

In simultaneous loadings of this nature the transformers must be designed for low reactance with interlaced windings and, of course, must have a 50 per cent voltage tap in each secondary winding.

The usual construction of a transformer of the distribution or power type is the two-legged core type designed for series or multiple connection but not for three wire service. The total impedance of the transformer may be low but the impedance between the two halves of the secondary winding may be extremely high thus causing poor regulation in the 230 v. circuit when the transformer is connected in a double delta circuit.

If three transformers with interlaced windings and low impedance are connected for simultaneous double loadings and all the load is connected to the 460 v. circuit the transformers will, of course, have a capacity of 100 per cent of rating. Also if the entire load is on the 230 v. circuit the capacity of the bank will be but 50 per cent of rating because of the double current at half the rated voltage. When simultaneous loads are imposed on a bank the total 230 and 460 v.

loads, without overloading the transformers, will be somewhere between 50 per cent and 100 per cent of the bank rating depending on the extent of the two respective loads and also upon the respective power factors of the two loads. For example, if the power factors of the two loads are the same, with 50 per cent load on the 460 v. circuit but 33 per cent of the rating may be applied on the 230 v. circuit without overloading the transformers. If the power factors are not the same on the two loads the permissible simultaneous loads will be less than with the same power factor.

All loadings and ratings mentioned herein are, of course, in kv-a and not kw.

Transformers in Open Delta

Two transformers in open delta may likewise be loaded with double secondary loads if the transformers are properly designed for double delta. However, this is not a symmetrical connection and the regulation of the three phases will be different and may result in distorted voltage and unsatisfactory operation. The capacity of an open delta bank is 57.7 per cent of the capacity of the closed delta bank with all individual transformers of the same rating while each individual transformer in the bank of two has a capacity of but 86.6 per cent of its rating as a single transformer. This is due to the 30 deg. phase displacement existing in the open delta bank. When two transformers are connected in open delta and with double secondaries the maximum load that may be applied, and stay within the ratings, is 86.6 per cent of the individual rating when the entire load is connected at 460 v. and 43.3 per cent when the entire load is connected 230 volts. If 50 per cent of the kv-a. rating of the transformers in open delta, which is 43.3 per cent of the individual transformer ratings, is applied at 460 v. but 21 per cent of that rating may be applied simultaneously at 230 v. and stay within the transformer ratings. This is with the same power factor in both loads. If the power factors of the two loads are not the same the total permissible loading of the transformers will be slightly increased.

From the foregoing it is seen that 230 and 230 do not necessarily equal 460 and that two loads that add up to 100 per cent of the rating of a bank of transformers may in reality be an overload.

Cost of By-Product Steam for Heating

Few plants have any clear notion of what by-product steam for heating costs. This steam is not secured for nothing. Important management decisions will be based upon an accurate determination of exhaust steam costs.

By EUGENE CALDWELL
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Milwaukee, Wis.

MANY COMPANIES operating their own power plants and using the exhaust steam for heating or processes have a very hazy idea of the cost of such steam. Indeed not a few companies have the conception that their by-product steam costs them nothing because they have to generate it anyway.

Numerous times I have heard the statement, "We either get our power for nothing or our heating without cost, whichever way you want to figure it." Nothing could be farther from the truth. Both the power generated and the steam for heating have a definite value, and with proper power plant accounting actual costs can be allocated to each item. Such a determination is absolutely necessary in order to make intelligent decisions in connection with all power and heating requirements.

Many companies operating their own private power plants also have a connection with the local electric company's system. Where the purchase power contract is at all favorable and the plant's generating equipment somewhat out of date, it is not unusual for the company to purchase their power requirements during the summer months and then generate energy needed during the heating season. It is not uncommon for the fuel costs of the private plant to exceed the cost of purchased energy per kw-hr.

Determination of Steam Costs

In these cases a determination of the cost of the steam used for heating is a simple matter. It should be remembered that every kw-hr. generated in the company's private plant eliminates a kw-hr. that would otherwise be purchased. Consequently the kw-hr. generated is worth exactly what it could have been purchased for.

Note that this purchased cost per kw-hr. should *not* be taken as the average purchased power cost per kw-hr. obtained by dividing the total bills over a period by the kw-hr. purchased in that period. The figure that should be used is the cost of additional energy that would be purchased on top of what is already being purchased; in other words the energy rate for the last step on which your plant is now working, less all discounts, coal factor deductions, etc.

Therefore the fuel cost of the exhaust steam used for heating is the difference between this purchased power cost and the fuel cost for the live steam. Live steam fuel costs of course would be the costs of the fuel used divided by the number of 1000 lb. of steam developed without any deduction for generated power credit. It is not impossible for circumstances to be such that it would be cheaper to use live steam in the heating system than to make power first and use the exhaust steam for heating.

Even where there is no connection with an outside power company and all requirements are generated within the company plant, the same comparison can be made. Power generated in any plant is worth no more than the cost of the substitute purchased power. Accordingly it would be well for every such plant to check purchased power rates and determine what the most favorable power contract that could be obtained involved. In this case, however, there would have to be credited against the live steam costs more than the bare purchased power cost if any investment is required such as for a sub-station, motor-generator set, or minimum guaranteed bill.

When the actual cost of exhaust steam is arrived at, it may be found profitable to replace antiquated generating units by modern apparatus that would handle the steam more efficiently. Remember if 2 kw-hr. can be generated from the same steam as one was generated previously, then there is 2 kw-hr. of purchased power to credit against the live steam costs. If private generating units can be obtained so efficient that energy can be generated as cheaply as it can be purchased, then the cost of the exhaust steam used for heating is zero.

Analysis of Costs

A good illustration of the factors involved in such a proposition is the case of a plant in the middle west. For many years the company had operated its own power plant, using a Corliss engine with a slide valve engine unit as a stand-by. In later years a favorable contract was negotiated with a local power company so it obviously was not profitable to operate the private plant except during the heating season.

The management was not particularly concerned with the economy of the generating unit since the steam was needed for heating, and any energy generated at all was considered just that much gravy. But then it was decided to make a determination of the cost of the exhaust steam used for heating, and some startling results were brought out.

Since meter readings over a reasonable period showed that 10.1 gallons of fuel oil was used per 1000 pounds of steam generated, the fuel cost of live steam was determined to be 36.6c per 1000 lb. with oil costing 3.615c per gallon delivered.

The power purchased over a two-year period averaged 6.69c per kw-hr. However, the plant was working on the step of the rate where energy cost 0.976c per kw-hr. and any additional energy purchased (not generated) would have cost this amount.

Consequently a kw-hr. of energy generated when exhaust steam was needed is worth exactly 0.976c per kw-hr. The water rate of the Corliss engine was found to be around 54 lb. of steam per kw-hr. The fuel cost of 54 lb. of live steam (at 36.6c per 1000 lb.) is 1.975c.

In this particular plant the generating unit is d.c. whereas the purchased power connection is a.c. About half the plant equipment is d.c. and the other half a.c. But any additional energy requirements needed would be a.c. A motor-generator set ties the generating unit with the purchased power connection. Estimating the overall efficiency of the motor-generator set at 80 per cent, then 0.8 of a kw-hr. of a.c. energy would be generated with 54 lb. of steam. Thus 0.8 of 0.976c or 0.7808c is the value of 1 kw-hr. generated.

Subtracting this from 1.975c gives 1.1942c the cost of 54 lb. of exhaust steam or 22.1c per 1000 lb. In other words there is a saving of only 14.5c per 1000 lb. by using exhaust steam over the cost of heating directly with live steam.

The cost of exhaust steam as against live steam is not exactly comparable on a basis of 1000 lb. of steam because live steam has a slightly greater heating value than low pressure steam. The comparison should be made on a B.t.u. basis. Any steam table will show the total heat in the steam at both the live steam pressure and at the exhaust pressure.

As would be expected, the Corliss engine was very wasteful of steam, 54 lb. per kw-hr. being quite high. Good performance of a modern high pressure non-condensing steam turbine 300 kw. capacity operating between 120 lb. pressure and 3 lb. back pressure would be about 30 lb. per kw-hr. A large plant would better this to a considerable extent.

This is about 2 times the energy secured from the same volume of steam. If instead of 1 kw-hr. for 54 lb. of steam, 1.8 kw-hr. could be generated, then a credit of 1.8×0.7808c or 1.408c could be made against the fuel cost (1.975) of 54 lb. of steam. This would make 1000 lb. of exhaust steam cost 10.5. If 2½ kw-hr. could be generated with 54 lb. of steam then the cost of exhaust steam would be zero; as a matter of fact the purchased power costs would then be greater than the fuel costs of energy generated, and other things being equal it would pay to generate energy the year around rather than purchasing it, in which case a condensing unit would probably be considered for summer operation.

Bear in mind the additional energy could be generated with more modern prime movers without any additional load whatever on the boiler plant. In making such a finding, however, it should of course be determined if all the additional energy possible to generate could be used within the plant; otherwise these added kw-hrs. could not continue to be credited against the cost of by-product steam.

Since the annual requirements for heating and processes within the plant in question is around 12,600,000 lb. of steam, there would be a theoretical saving in fuel costs annually of $1460 by the installation of more modern generating equipment. Naturally this caused the management to check thoroughly the advisability of installing a modern non-condensing or bleeder type turbine. Fixed charges must obviously be added to the fuel costs when comparing operations requiring an outlay of funds beyond existing equipment. This saving, however, would go part way toward the first cost of a new unit of modern design.

High Limits —Low Limits

A semi-technical discussion of the desirability, practical considerations and limitations of temperatures and pressures at both ends of the power generating cycle. A consideration of relative advantages.

By M. T. LEWELLAN,
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State College, N. Mex.

ONLY A GLANCE at recent numbers of many of the periodicals which contain articles on the advancement and improvement in power generating stations, is needed to show a marked trend toward the use of higher pressures and temperatures and lower exhaust pressures. Many station operators are beginning to wonder just what the limits in this trend are, and what advantages can be gained.

Fundamentally, a power plant, whether operated by a steam-driven prime mover or by one of the internal combustion engine types, is a heat transfer type of cycle. All such cycles depend for their efficiency upon the temperature difference between the source and the receiver. Consequently an increase in the upper temperature, or a decrease in the lower temperature, results in a greater proportion of the energy received by the fluid being converted to useful work.

Lower Limits

A few remarks regarding the limit to which the lower temperature can be carried will be made first, since there does not seem to be much chance in carrying this phase of the cycle much below present practice. The average yearly temperature of our large bodies of water, such as oceans, lakes, and rivers, is approximately 40 deg. F. The steam from most condensing cycle units is wet and saturated at its exhaust or condenser state and would ordinarily be at a saturation temperature corresponding to its pressure. The saturation pressure corresponding to a temperature of 40 deg. F. is very close to 0.25 in. of Hg. abs. This corresponds to a vacuum of 29.75 in. Hg. referred to a 30 in. barometer, which is very difficult to maintain, except possibly with the most modern and up-todate condensing equipment.

Many units are operating on an exhaust pressure of 1 in. Hg. abs., which carries a saturation temperature of approximately 79 deg. F. Any attempts to constantly and economically maintain lower temperatures are questionable from the standpoint of the statement made earlier in this paragraph. It is remarkable that commercial equipment has been designed and built which will effectively maintain such a high vacuum, when it is realized that the ultimate limit in this direction, namely, 30-in. Hg. vacuum, has never actually been reached, even experimentally.

Upper Limits

The upper temperature limit can be approached in either of the two ways: by increasing the pressure of the steam; or, by adapting the use of higher superheat. In the case of saturated steam, the temperature increases with an increase of pressure up to the critical point. Present tables on the properties of steam do not carry the pressure with its corresponding saturation temperature beyond 3206.2 lb. per sq. in. abs, at which point the temperature is 705.4 deg. F. Probably the reason for discontinuing the table at this point is that this is the critical pressure for steam, the pressure at which water passes from water at 705.4 deg. F., steam at a temperature of 705.4 deg. F., without the addition of any latent heat. There are one or two experimental plants in this country for generating steam at up to 3500 lb. per sq. in. abs. and two 2400 lb. plants which will soon be in operation.

The increase in capacity of many stations by the addition of a "top" unit is simply the addition of an extremely high pressure turbine with its generator, whose exhaust may be practically dry and capable of delivering a considerable amount of energy through the conventional moderate-pressure-range turbo-generator set. This statement does not intend to leave the impression that every plant can economically increase its capacity by adding a "top" unit. Many considerations, such as present steam generating equipment, physical arrangement of the plant, and load demands and fluctuations, must be taken into account. These items directly affect the cost of such an addition and may result in too great an outlay for the increased capacity.

Wet Steam

Since the steam turbine came to the front as the preferred type of prime mover in the large-scale production of power, the use of dry and saturated steam was more or less discarded. This was probably due to the damaging effect of small droplets of moisture on the turbine blading, at the high peripheral speeds involved. In some turbines (single stage) the velocity of the steam leaving the nozzles may be as high as 3000 to 3500 ft. per sec. If steam leaves the boiler in a dry and saturated state, it no doubt has a small per cent of moisture present by the time it reaches the turbine. This moisture content increases as the expansion progresses and has the same effect on the blading as though a number of small lead pellets were directed on to it, and pitting of the blading is the result. The above condition can be improved by the use of highly superheated steam. With very high vacuum, however, it was found that even at exhaust the quality might be as low as 90 per cent. Most recent trends indicate that a maximum of 13 per cent moisture is the practical limit in this direction.

The maximum upper temperature limit appears

Continued on Page 64

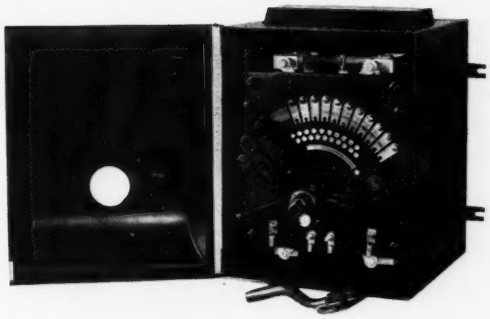


Fig. 1. Face late type starter

Selecting Starters for D. C. Motors

By L. E. MARKLE
Control Engineer, Westinghouse Elec. & Mfg. Co.

ELECTRIC MOTORS are purchased to drive certain definite loads in accord with the needs of the particular application. Starters and controllers for motors are made to regulate the starting and running operations and to provide desirable operating features without injury to the equipment. For a given installation, therefore, it is first necessary to select the most suitable motor and then arrange for the correct starter or controller.

Shunt Motors

The outstanding characteristic of the direct current shunt-wound motor is the relatively small change in speed from no-load to full load conditions. Shunt wound motors must not be started at full voltage. Resistance is used to first apply reduced voltage to the motor terminals. As the motor accelerates the resistance is short-circuited and full voltage is finally applied to the motor terminals. If necessary a rheostat may be used in the shunt field circuit to increase the speed above the normal value. The speed adjustments are made in fine steps by using a large number of points on the rheostat.

Compound Motors

Some applications require motors that have considerable change in speed from no-load to full load. Sometimes a motor is required that will deliver rather high overload torque without excessive overload currents. If either or both of these requirements are essential then the compound motor will be the desirable choice.

Compound motors generally require resistance starters but small ratings can be made suitable for starting at full voltage. They cannot be operated over wide speed ranges by shunt field control.

Series Motors

Series motors develop very high torques without taking excessive currents from the line. They are, therefore, capable of delivering high starting torques at low starting currents. The speed varies greatly with the load and would be excessive at no-load. Series motors must, therefore, always be partially loaded to prevent runaway speeds.

The relatively high speeds at light load and slow speeds at heavy load make the series motor an ideal choice for crane and hoist applications. When hoisting heavy loads the speeds are low and loads can be carefully handled. At light loads where less care is required the higher speeds permit rapid handling of materials.

Adjustable Speed Motors

The shunt and compound motors described heretofore are often termed constant speed motors because they permit comparatively little or no speed adjustment by using resistance in the shunt field circuit.

The adjustable speed motor is commonly used to obtain a maximum speed of four times its normal speed. Higher ratios have been used. While the speed change from no load to full load is not as small as for the shunt motor it is highly satisfactory. The use of resistance in the shunt field circuit permits speed adjustments in a large number of steps by use of the multi-point field rheostat.

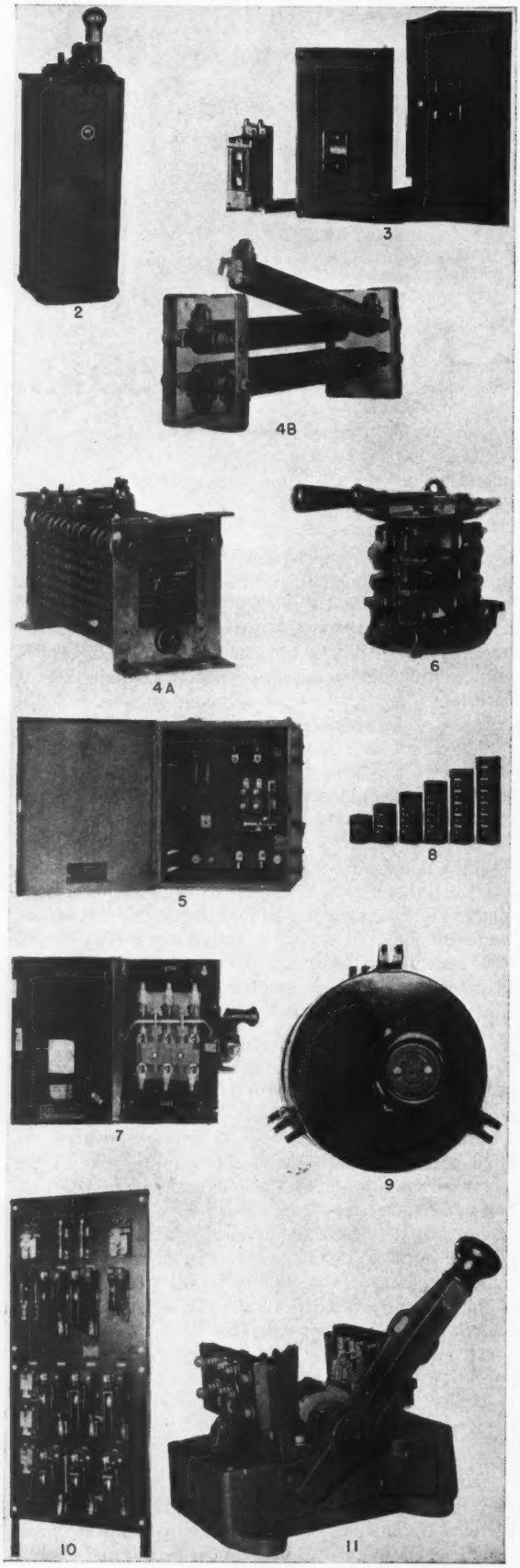
Types of Motor Starters

Motor starting and control equipment may be divided into two large groups commonly known as manual and magnetic types.

Manual starters, as the name implies, are manipulated entirely by an operator to close and open the motor circuits, whereas the magnetic types use contact making devices—called magnetic contactors—that are operated by electro-magnets. The closing and opening of a knife switch or the operation of the light switch in a home are examples of simple forms of manually operated devices. The magnetic type of installation is illustrated by the use of a panel type construction that may be remotely mounted and all operations controlled through a master station such as a push button or by some automatically operated device such as a thermostat or float switch.

Manual Starters

Manual type starters are generally more simple and less expensive than magnetic types. For high voltages the insulation and current interrupting problems become more difficult, hence the magnetic types



are generally used on circuits above 230 v.

On large motors the currents are relatively high and the current carrying parts of a starter or controller must be appreciably large. Manual devices, therefore, for the higher ratings become impractical to build. In fact large sizes may have so many movable parts with effective spring pressures so high that it becomes physically difficult to operate them. It would be impossible for a man to operate them frequently or rapidly. For relatively small ratings and circuits of 230 v. and below the manual types are compact, inexpensive and entirely satisfactory.

Types of Manual Starters

Practically all types of manual starters are illustrated by the face-plate designs of Fig. 1 or the drum types of Fig. 2.

The face-plate designs of Fig. 1 have the resistors, associated with them, mounted in the same structure and connected to the various contacts. The completed unit is, therefore, self-contained and only the incoming power leads and motor leads need be connected to place the units in service. Various combinations of the face-plate designs are made to permit starting duty only; starting duty and speed control by armature resistance; starting duty and speed control by shunt field resistance and starting duty with speed control by both armature and shunt field resistance.

Face-plate starters are generally built only for non-reversing service. They are compactly built, require small space for the features provided and are relatively inexpensive. They are used on both shunt and compound motors. They are built to prevent unexpected starts after voltage failures or other interruptions, in order to provide protection to machine operators. Overload protection is not included in the design. It is obtained by using a power disconnecting circuit breaker with overload trip units or a fused safety switch as shown in Figs. 3 and 7.

Drum controllers such as that shown in Fig. 2 are more rugged both electrically and mechanically, than face-plate designs. They are built to provide either reversing or non-reversing service and are used with all types of d-c motors.

They do not represent complete equipment because the resistors used with them are separate assemblies. The resistor units may be either the ribbon or grid type shown in Fig. 4a and 4b. The ribbon type is capable of withstanding high temperatures without damage; is light in weight and unbreakable. The grid type is heavier and of greater thermal capacity.

Protection against overload and unexpected starts after interruptions must be obtained by adding a protective panel with a magnetic line contactor and overload relay as illustrated by Fig. 5. An installation consisting of drum controller Fig. 2, resistor Fig 4, and protective panel Fig. 5 will, of course, require all units to be properly inter-connected at installation time.

Fig. 2. Drum type of manual starter. Fig. 3. "Nofuze" circuit breaker. Fig. 4a. Grid type resistor unit. Fig. 4b. Ribbon type resistor unit. Fig. 5. Protective panel. Fig. 6. Drum type controller often used to start motors. Fig. 7. Non reversing general purpose starter. Fig. 8. Push button assemblies used with d.c. starters. Fig. 9. Shunt field rheostat. Fig. 10. Reversing controller providing dynamic breaking. Fig. 11. Rugged master switch used to control operations instead of the pushbuttons of Fig. 8.

Figure 6 illustrates a drum type controller that is often used to start motors for either reversing or non-reversing service. It is used with motors of relatively small ratings, either at full voltage or with a single step starting resistor.

Magnetic Starters

Magnetic starters make available many features of operation that are not reasonably possible with the manual types. Although the manual starters were first to be developed and will always be necessary they are not used so generally as the magnetic types.

When a magnetic type starter is used the judgment of and reliance upon an operator are of less importance than when a manual starter is used. Since the acceleration of a motor using a magnetic starter is generally controlled by automatic means the number of accelerating points on a magnetic starter is less for a given size motor than on a manual starter.

Installation of the control units in a remote location is common when magnetic starters are used. Valuable floor space is saved by placing starters on the wall, mounting them on balconies, or grouping them in separate rooms. For those installations where self-contained machines are desired the magnetic starter may be mounted upon the machine or it may be assembled in several parts, if necessary, and enclosed within the machine itself. The master station which the operator uses to initiate different operations is relatively small and easily located in a place convenient for the operator.

Operation

The use of magnetic starters makes possible the automatic features of operation that are found so frequently today. A motor, magnetic starter and float switch will automatically maintain a desired water level without any attention from an operator. The substitution of a pressure switch for the float switch provides equipment to automatically maintain a given pressure on a system.

Suitable auxiliary devices known as limit switches, timing switches and relays of many different types permit most any conceivable combinations of operations. By their use motors rotate one direction for a period, then stop almost instantly and rotate in the opposite direction. They may be made to run faster in one direction than the other. Such operations are possible with the magnetic starter but quite impractical with the manual types.

Accelerating D.C. Motors

Since very few d.c. motors can be started at full voltage one function of practically all d.c. motor starters is to accelerate the motor from standstill to its operating speed. In case no shunt field control is provided the accelerating process consists of reducing the external resistance in the armature circuit from its maximum value to zero in a suitable number of steps. The proper number of steps will depend upon the maximum current that may be permitted in the armature circuit and the load on the motor.

For adjustable speed motors shunt field control is used to operate at speeds above the normal motor speeds. Some starters are arranged so that the field rheostat must always be placed in the low speed position before the motor can be started. The acceleration problem is then exactly the same as outlined above. After the acceleration is completed the desired speed is obtained by moving the field rheostat to the proper position.

There are many manufacturing processes that require a certain best operating speed in order to obtain a uniform product. If an occasional stop must be made it is necessary to return to the desired operating speed in a minimum time to avoid loss of product. This type of starter is commonly known as a pre-set speed type. In this case the field rheostat for speed adjustment is set for the correct speed and is not changed. When starting the acceleration must be automatically controlled from zero speed to normal speed as outlined before and in addition the motor must be smoothly accelerated from normal speed to the productive speed for which the field rheostat is set.

Automatic acceleration of a motor is accomplished by different means but the three most common methods are the cemf, current limit, and definite time schemes.

The cemf scheme employs the increasing armature voltage, as the motor accelerates, to actuate magnetic contactors to short circuit successive steps of the starting resistor. The scheme is probably the simplest and least expensive. It is not well adapted to large motors where many steps of resistance are used or on systems where the supply voltage varies over wide limits.

Current limit acceleration uses the motor current to determine when successive points of acceleration shall occur. If the current is higher than the device settings the acceleration does not progress. This form of acceleration is very satisfactory when loads of high inertia, are to be started. The scheme allows a motor as much time as is necessary to accelerate with safety. If the motor must accelerate a higher load than anticipated the current devices may not be set satisfactorily; hence they will not function; the motor will not accelerate and the starting resistor will be damaged unless it is designed for continuous duty.

The definite time scheme of acceleratoin is forced acceleration. If the motor should not start at the moment power is applied the starting resistance is reduced anyway and eventually the motor will be connected directly to the line. The motor must start or eventually be disconnected from the power supply by the action of the overload relay. This is the type of acceleration in most common use today.

Stopping D.C. Motors

Many motors are permitted to "coast" to a stop after power is disconnected simply because there is no need to stop the motor quickly. There are applicatoins where time is an important factor and the need for quick stops and rapid reversals is imperative.

Dynamic braking is probably the most common practice for quickly stopping a d.c. motor. During this process the motor is acting as a generator, disconnected from the power supply, but connections made to apply a loading resistor to the "generator". The inertia of the rotating parts is quickly dissipated in the loading resistor and the motor is promptly stopped by its electric or dynamic braking.

For extremely rapid reversal of operating direction, motors are sometimes "plugged" to a stop and then automatically accelerated in the opposite direction as rapidly as possible. Plugging a motor means that while running in one direction the connections are quickly rearranged to apply power to run the motor in the opposite direction. The controller will protect the motor against excessive currents during the "plugging" period and will promptly and automatically accelerate it in the reverse direction.

Protection

Practically all magnetic starters provide overload protection. Overload relays are generally the inverse-time-delay type which operate in a short time at high currents but require more time to operate at lower currents. Most inverse-time-delay overload relays are of the thermal type. These relays do not operate during the starting period when high currents of short duration occur but will operate if long time overload currents occur that really endanger the motor.

Magnetic starters provide either "low voltage release" or "low voltage protection." The former term indicates a circuit that will permit restarting when voltage returns after a power failure without attention by an operator. Fans and water level pumps are examples of such applications.

"Low voltage protection" indicates a circuit that prevents unexpected starts after a voltage failure; hence it requires the attention of an operator to restart the motor. Machine tool applications always require "low voltage protection" to protect operators against unexpected starts.

If the shunt field of a motor opens due to broken wires or any other cause while power is applied, the armature speed instantly rises to dangerous run-away values. To prevent such damage relays may be used whose coils are connected in the shunt field circuit. The contacts of the relay operate exactly like a stop button. With a field loss relay, therefore, all power is automatically disconnected from the motor in case the shunt field circuit should accidentally be opened.

Figure 7 illustrates a typical non-reversing general purpose type starter suitable for use in connection with machine tools, fans, pumps, blowers and similar applications. These starters are enclosed in cabinets or mounted on open panels. The starting resistors are mounted on the rear of the panel but for large sizes are a separate assembly.

Typical push button assemblies used with d.c. starters are shown in Fig. 8. A shunt field rheostat for use with d.c. starters and motors is shown in Fig. 9.

Figure 10 illustrates a reversing controller that provides dynamic braking to effect a quick stop. This type of controller is used in heavy duty service such as steel mill operations where extremely rugged apparatus is required to withstand severe service, frequent operations and dirty operating conditions.

In connection with the controller of Fig. 10 a rugged master switch as shown in Fig. 11 is used to control the operations instead of the push buttons of Fig. 8.

By several changes in the apparatus on the panel of Fig. 10 and the circuits in the master switch of Fig. 11 this same type of equipment can be made to provide "plugging" instead of dynamic braking to effect quick stops and rapid reversals.

High Limits—Low Limits

Continued from Page 60

to be influenced or determined by the advancements made in the development of metals used in the construction of the tubes of a boiler. These tubes usually provide the greater portion of the heating surface of a boiler and practically all of the heating surface for a superheater unit. The outside of the tubes is exposed to the maximum temperature in the firebox of the boiler at from 2500-2000 deg. F. although the temperature in spots may be approximately 3500 deg. F.

The water or saturated steam will be on the inside of these tubes. So long as this condition exists, the structure of the metal is not particularly damaged, but if this heat transfer is disturbed or interrupted from any cause, the heat piles up in the metal and begins to break it down very rapidly. At this point the principal difference between ordinary metals and specially designed metals makes itself apparent. Specially designed metals contain certain alloys which render the metal as a whole resistant to break-down under such conditions.

Naturally, tubes made from these superior steels are more expensive, but their cost is offset by improved efficiency in the plant. Likewise, metals possessing similar properties should be available for use in the construction of turbine blading. In these blades, the properties of tensile strengths, toughness and resistance to shock are just as important as the resistance to break-down by heat or extremely high temperature.

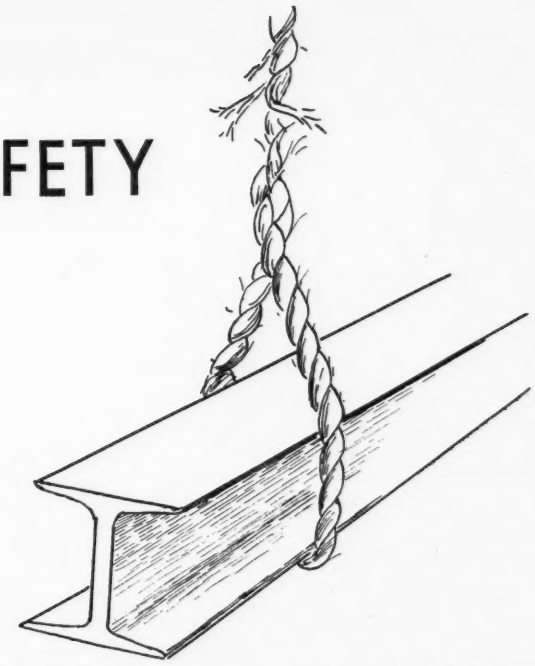
A summary of these remarks may be stated as follows: Any development or improvement which will allow the upper-temperature limit of the power-plant cycle to be increased, will result in an increased over-all efficiency. Likewise, any improvement which will decrease the lower temperature of the cycle will result in an increase of plant efficiency. In order for the first statement to become a reality, research in the field of alloy steels must keep pace with the efforts of engineers to design and build generating equipment to operate on these higher temperature and pressure cycles. As far as the lower temperature limit of the present cycle is concerned, there does not appear to be much improvement possible, except as continued research may make higher vacuums available.

DURING the first three months of 1940, General Electric Company's suggestion system paid 31 per cent more to employees of the company than it did for the first three months of 1939. For January, February and March a total of $17,587 was paid for adopted ideas relating to their daily work, as contrasted with $13,461 for the same period in 1939.

The number of suggestions received for the period showed an increase of 11 per cent and the number of suggestions adopted increased 21 per cent.

FACTOR OF SAFETY

Its Significance, Purpose, and Shortcomings.



By
C. O. von DANNENBERG

THE DESIGNER of any structure or piece of equipment, in fact, the planner of any engineering project, usually makes certain allowances beyond the requirements anticipated during normal use. The layman or person uninformed concerning technical details may with justification ask, why the necessity of this allowance or margin.

It is quite usual to find allowances made in calculations which give an estimated or theoretical ratio between the ultimate (breaking) strength of the material and the assumed working strength. For example, it is quite common to find a factor of 4 or even higher for building structures and rarely does one hear of a factor of less than 2.

The question, for the necessity of such high factors, is a pertinent one. If, for instance, we assume the ultimate strength of steel to be 60,000 lb. per sq. in. and our maximum working strength 15,000 lb. per sq. in., then our theoretical factor is 60,000/15,000 or 4. If we increase our maximum working stress to 20,000 lb. per sq. in., the theoretical factor becomes 3.

THIS short discussion about Factor of Safety by Mr. von Dannenberg emphasizes a number of elements of great importance in engineering design. Too often in the design of engineering structures a large factor of safety is only a scientific smoke screen employed to hide a large amount of ignorance. As the author points out, there is more merit in building a structure that will sustain the normal loads for an indefinite time with perhaps only a small margin of safety than to build a more costly one which may never during its normal life be called upon to carry the burden for which it was supposed to be designed. It is often cheaper to have to rebuild a structure which failed as a result of abnormal conditions than to build one which could resist abnormal conditions which may never occur.

This is an elementary case but the principle inherent in it is of considerable financial importance. Take, as an illustration, the case of a steel beam of a certain length having a certain loading. The weight of a beam is proportional to the product of its length multiplied by its cross sectional area which gives its cubical contents (volume); this result multiplied by the weight of steel per unit of volume will give the total weight. The unit stress (pounds per square inch or other unit) being the total load divided by the total area, it follows that an increase in the unit working stress results in a smaller area for the same total loading and hence a smaller volume or lower weight of steel. The illustration given is a simple one but no lengthy consideration is necessary to conclude that a saving in initial cost will result; in fact, for the case cited of an increase in the maximum working strength of from 15,000 to 20,000 lb. per sq. in. will result in 15,000/20,000 or ¾ of the original area proposed from which it follows that the weight of the section will be three-fourths as much.

There are, of course, other factors that tend to reduce the assumed factor. For instance, in the fabrication of built-up composite steel structures, such as trusses or plate girders, the riveting and handling may introduce stresses which may be practically impossible of predetermination and hence may reduce the assumed factor to an even lower one. If then we make actual tests to destruction and find that the ratio of the loading at failure to the assumed maximum working load is 2, would we not be justified in assuming that the factor should be 2 in such cases instead of 4 as we had previously assumed? In fact, we would be forced to admit, to ourselves at least, that there was something wrong or uncertain in our design, and our assumed "FACTOR OF SAFETY" might be termed a "FACTOR OF IGNORANCE."

The point may be raised, and with justification, why do we not have more failures. The answer to this is a simple one. A certain maximum working condi-

tion is assumed and based on that assumed condition, a design is made allowing a "FACTOR OF SAFETY" for the assumed condition. As is usually the case, the maximum condition may very rarely occur, if it ever will, hence the "FACTOR OF SAFETY" for all practical conditions may be several times the actual factor it is assumed to be or, in other words, additional material is provided for a condition which may never occur. As a result, the initial cost may be higher to provide what might be termed "INSURANCE" or "ASSURANCE" for a situation of comparatively remote possibility.

Provision for Remote Contingencies

The provision for some abnormal condition assumes that we must have some knowledge about such a contingency. Take, for instance, the design of a building to withstand a cyclone or the design of a transmission system so that the structures and conductor will be sufficiently strong to withstand a loading of 4 inches of ice around the conductor combined with a wind loading of 8 lb. per sq. ft. of projected conductor area. The answer to the foregoing is a purely commercial one and to provide construction suitable for such service would mean an initial cost which might cause the complete discardance of the project. In other words, it could not be built for lack of sufficient funds, or such an investment could not be justified based on the estimated financial return.

A simple example is evident in the strength requirements of the cables in overhead transmission line systems. The maximum stress the conductors will be subjected to, under certain assumed loading conditions, shall not, depending on the regulatory requirements, exceed one-third (⅓) to one-half (½) the actual ultimate or breaking strength of the conductor. What this really means is, that we have under normal conditions, a ratio of the ultimate strength to the working loading of possibly 6 or 7 to 1 and are providing strength requirements which may rarely occur. A recent check of two transmission systems, in operation, respectively, for 26 years and 15 years, showed that neither had, in that period, been subjected to any condition even approximating the maximum assumed loading conditions or, in other words, considerable initial expense had been incurred, particularly as related to the supporting structure and other features which may not have been warranted, or at least could have been reduced. Whether the added interest charges, due to the greater initial investment, could be considered in the light of insurance, becomes then a matter of policy, experience or engineering judgment. The point is, however, that the ability to be able to put up a structure that will "carry on" for an indefinite period and sustain the normal loads to which it is subjected, is more of a tribute to the skill and judgment of the designer than the production of one which is not only more costly but may never during its normal life have to carry the burden for which it is supposed to be designed.

A recent comparison of two tower structures designed for approximately the same loading indicated that one design weighed approximately one-half of the other. The lighter structure being the product of an internationally known concern at once leads to the conclusion that the heavier structure could not have received, in its design, the thought or informed technical planning put into the lighter one.

Use Care in Selecting Materials

We often see situations similar to that described in the foregoing paragraph. Perhaps the best way, when purchasing such material, is to specify a definite loading with a certain margin and allow the tenderers to give the total weight of each structure, instead of simply offering material at a price per pound or per ton. It may be found that while in one instance the price per unit weight of the lighter one may be higher, the total weight and the total cost may be less.

When one considers the case of railway bridges and structures similarly used, certain concessions must be made for the safety of human life but, at the same time, there seems no justification in giving a so-called "FACTOR OF SAFETY" which may essentially be only a qualitative indication of the strength. On the other hand, the only true indication of the safety of any structure is a test made to destruction. It is not, of course, possible to make such a test for any or all situations but it is possible to make models, as has been done in the case of bridges where the stresses to which the component part are subjected may be studied at close range, under various types of loadings and so that the accuracy of the fundamental design features may be checked with certainty. The well known child's toy known as Meccano permits, with suitable modifications, the assembly of complicated structures and a study of their essential features.

To sum up the matter as a whole, the design of any structure or equipment, requires a knowledge, both technical and practical, of all fundamental features involved as well as their limitations. That there must be some margin of strength may seem a definite requirement so long as materials vary and knowledge is limited, but on the other hand, to provide for something which may never exist or to "throw in" material to take care of some unexpected or unknown feature, is neither an advantage nor a benefit and may actually involve much unnecessary cost. It seems therefore far better, and it is certainly much less misleading, to eliminate the term "FACTOR OF SAFETY" altogether and speak of "POSSIBLE OVERLOAD" which seems an expression better understood and about which there can be no misapprehension.

A pertinent commentary is the practice followed in European and other similarly situated lands, where basic raw materials are limited or not available while technical men and skilled labor is low in cost. Comparisons of bids for equipment based on and complying with all the requirements of definite specifications indicate clearly the more thorough theoretical consideration given to the design and fabrication of equipment through the minimum utilization of material without sacrifice of factors of reliability. This is in contrast to lands where raw materials are readily available and designs seem to tend toward finished products requiring less or simpler manufacturing methods due to the higher labor costs. There seems much to be said in favor of the conservation of material when strength and reliability are not sacrificed.

The Behavior of Watthour Meters at No Load

The problem of wear in watthour meters is of great importance to the public utility companies as well as other large users of watthour meters. While experience did not always prove it, there has been an assumption that the amount of pivot wear is roughly proportional to the total number of meter disk revolutions This was quite logical since the wear was obviously a function of the rotation of the pivot in its bearing. In this article, which is an abstract of a paper presented before the A. I. E. E. by F. C. Holtz, vice president and chief engineer of the Sangamo Electric Co., it is shown that the wear is due to other factors—that wear may take place when the meter is not turning. Aside from the intrinsic merit of the investigation to wattmeter designers and users, the method involved is of ample interest to warrant the attention of those not primarily concerned with watthour meters.—Ed.

IT IS GENERALLY known among electric metermen that the moving system of a.c. watthour meters under the condition of no load with potential element excited are in a peculiar state of vibration. This phenomenon frequently exhibits itself as a rattle or vibration of the upper pivot if unoiled and is easily felt by slightly touching the edge of the disk with one's finger.

A layman might think it strange that such an apparently trivial phenomenon could form the basis of such a careful study and analysis as is presented here but the technically inclined person will understand that just such apparently trival things often lead to important discoveries when properly analyzed.

It was, of course, natural that this vibration should have been of interest to such a man as F. C. Holtz, Vice President and Chief Engineer of the Sangamo Electric Co. of Springfield, Ill., but even so, allowing for his professional and commercial relation to the subject of meters, his resulting study and investigation of the phenomenon is worthy of high merit and should command the admiration of all interested in research. His complete study of the phenomena was given in a paper presented before the American Institute of Electrical Engineers[1] and those interested in his mathematical analysis of the subject will find this paper of interest; those not intimately concerned with the design and operation of watthour meters, while they may not care to study the mathematical aspects of the question, may still find his method of investigation interesting and it is for those that this abstract of Mr. Holtz' paper is presented here.

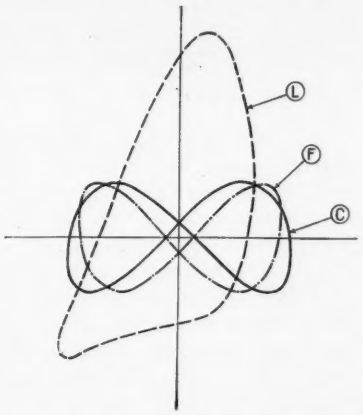


Fig. 1. Motions derived from simple theory

Mr. Holtz had discussed this question of meter vibration with George F. Shotter of London, England, and Mr. Shotter pointed out that under suitable illumination and with sufficient magnification the actual motion of the peripheral edge of the disk had been observed as a figure eight, characteristic of Lissajous' curves.

This was of interest to Mr. Holtz and the discussion led him to investigate the phenomena and develop methods for more accurately observing and recording the motion.

[1]The Anomalous Behavior of the Moving Systems of Single-Phase A-C Watthour Meters at No Load. Presented as Paper 39-114 before the combined summer and Pacific Coast Convention at San Francisco, Cal., June, 1939.

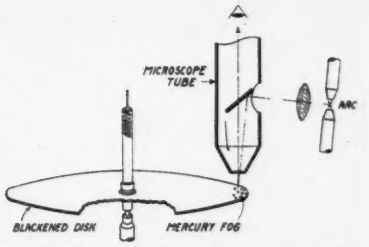


Fig. 2. Setup for observing motion at edge disk.

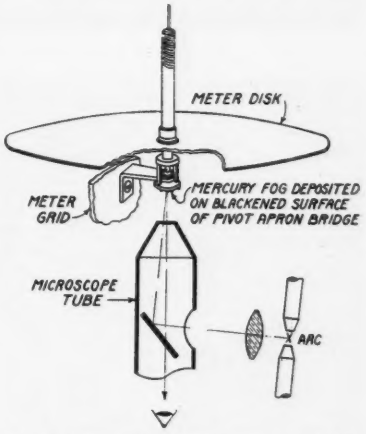


Fig. 3. Setup for observing motion at center of disk

Without describing the details, such motion can be predicated on theoretical grounds from a study and analysis of the forces acting on the moving element of the meter. By the appropriate choice of constants and transformation equations the relative motions were plotted with the results shown in Fig. 1. In this diagram C represents the motion in the center of the disk, L the left peripheral edge, and F the front peripheral edge between the magnets. It will be seen that these curves do represent with considerable accuracy the nature of the observed motion—curves C and F are definitely figure eights.

Now it must be understood that these curves were drawn purely from theoretical analysis and it was desirable to test the accuracy of the method by actually observing or photographing the motion. A method was, therefore, developed which is described in the following paragraphs, abstracted from Mr. Holtz' paper before the A.I.E.E.

Since the magnitude of motion was extremely small and the observations had to be made with-

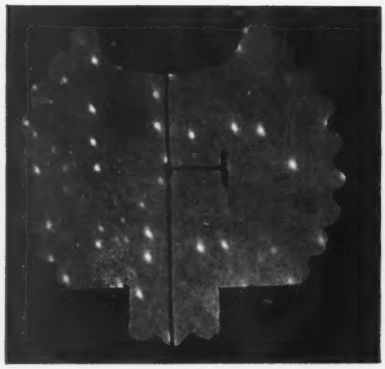


Fig. 4. Center of disk, no excitation

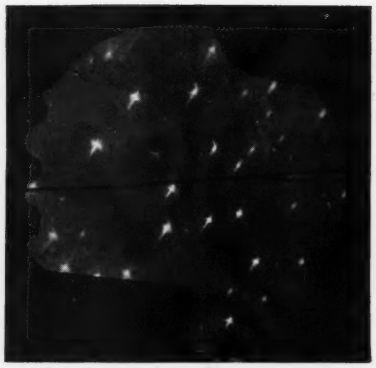


Fig. 5. Left edge of disk, no excitation

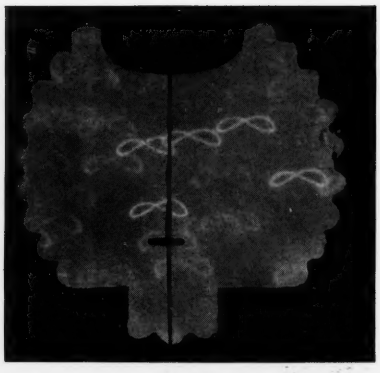


Fig. 6. Center of disk, 115 v. 60 cycles

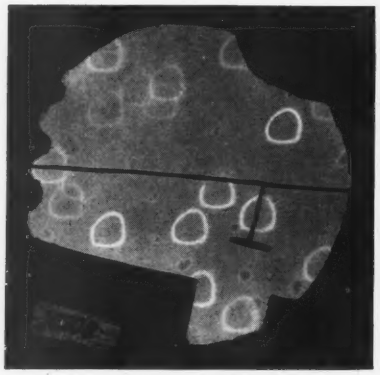


Fig. 7. Left edge of disk, 115 v. 60 cycles

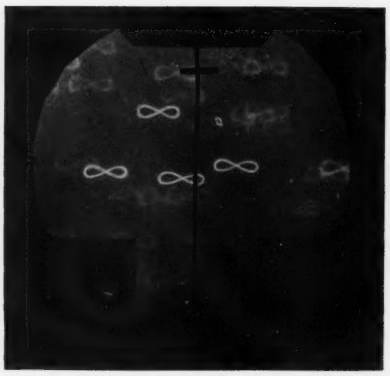


Fig. 8. Front edge of disk 115 v. 60 cycles

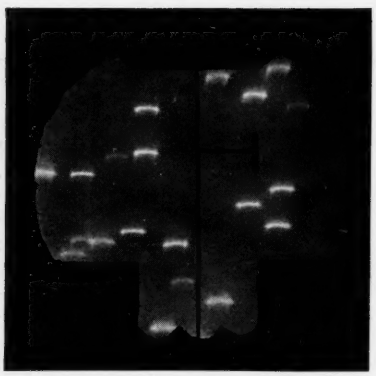


Fig. 9. Front edge of disk 90 v. 60 cycles

out interfering with the general arrangement of meter parts, a photographic record was made not without some difficulty. A simple and also beautiful procedure was finally arrived at in the following manner.

The disk was first given a heavy coat of lacquer heavily charged with lamp black. This, on drying, gave a surface which produced no reflection and hence appeared uniformly black even under intense illumination. The surface was then momentarily subjected to the action of mercury vapor which collected small globules of the order of 0.0001-inch diameter and smaller. These small globules would remain on the surface undisturbed and when viewed with a microscope of high magnification and intense vertical illumination the appearance was that of a star image of unusual brightness and small size. When the disk was in motion each tiny spot, due to persistance of vision, produced a true figure of the motion which could be measured and photographed. The general arrangement of apparatus is shown in Fig. 2.

In order to observe and record the motion of the center of the disk, the arrangement shown in Fig. 3 was used. In this case the jewel screw was replaced by a small bracket secured to the meter grid and on this was mounted the jewel which supported the meter pivot and moving system. By cutting away the dust cap surrounding the pivot until it resembled an inverted U it was possible to bridge this with a small strip on which the mercury globules had been deposited. The microscope in an inverted position gave the desired view.

Figures 4 and 5 are photographs showing the appearance of the illuminated points at the center and left edge respectively for the condition of no current and no potential excitation. In these as well as subsequent photographs the magnification was 500 diameters. Since there was some possibility that the motions might be influenced by the location of the anti-creep slots, these were marked on the negative by a short bar connected to the center of the disk. No appreciable influence was observed, however.

Figures 6, 7 and 8 show the motion for no current and normal excitation for the center, left edge, and front, respectively. The close similarity between these three photographs and those shown in Fig. 1 is to be noted.

As is to be expected, a reduction in voltage gave a corresponding reduction in motion. This is shown in Fig. 9 which shows the motion at the front edge of the disk when the voltage is reduced from 120 to 90. Similar pictures were made of the center and left edge of the disk but these are not shown here since the effect was essentially the same in the case of the front edge. In a like manner, increasing the voltage makes the effect more pronounced as shown by Fig. 10 which illustrates the motion of the pivot at 135 v.

Various effects were obtained by removing one or more of the permanent magnets and while the pictures showing these effects are of interest from the meter designers standpoint they are not essential to an understanding of the method, hence they are not reproduced here. All appear in the original paper, however.

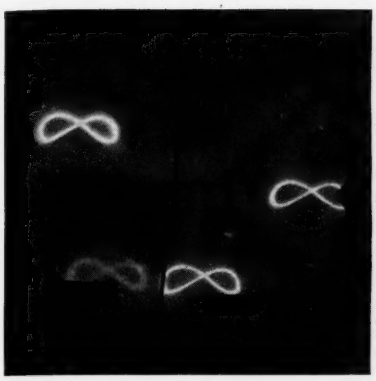


Fig. 10. Center of disk, 135 v. 60 cycles

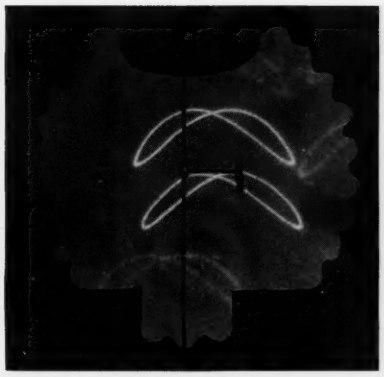


Fig. 11. Center of disk 115 v. 40 cycles

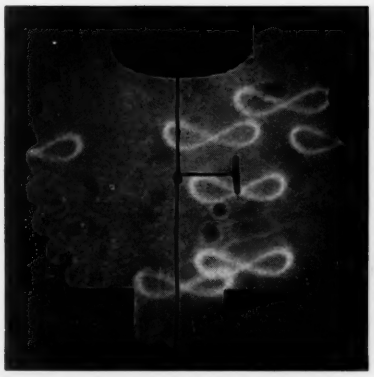


Fig. 12. Ball bearing construction. Center of disk, 115 v. 60 cycles

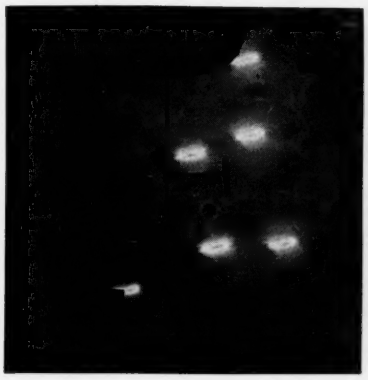


Fig. 13. Ball bearing construction. Center of disk 30 v. 60 cycles

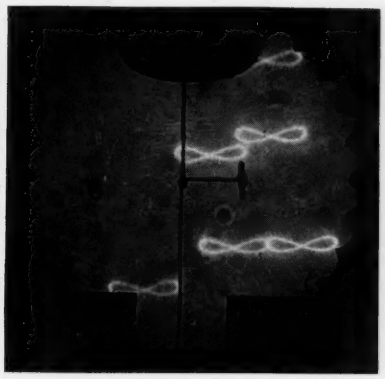


Fig. 14. Ball bearing construction. Center of disk, 90 v. 60 cycles

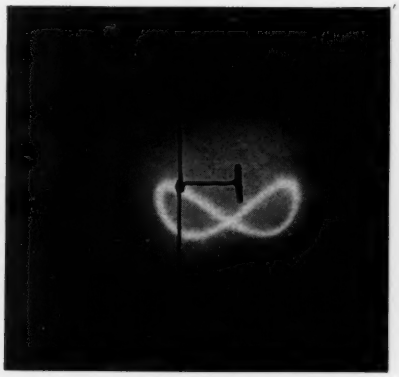


Fig. 15. Ball bearing construction. Center of disk, 180 v. 60 cycles

Many other effects can be produced according to the variations made in the factors going into the constants of the equations. A reduction in frequency for example greatly amplified the figures as shown by Fig. 11.

Behavior of Moving System With Ball Bearing Supports

Because of the equally common use of the ball type bearing, further tests were made to determine the relative motion of the disk under operating conditions similar to those applied to the meters with pivot type bearings. In this type of bearing a 1/16 in. ball moves between two sapphire cup jewels of approximately the same dimensions as those used with the pivot-type bearing. One jewel is carried by the meter spindle while the other is mounted in the lower jewel screw.

Figure 12 shows the motion of the center of the disk at 115 volts, 60 cycles. This should be compared with Fig. 6 which shows the motion of the center of the disk using a pivot-type bearing under similar conditions. It is to be noted that in this case the extent of oscillation is approximately double, indicating greater freedom of motion but not entirely so. The mechanical characteristics of the system are such as to permit a greater motion under the same forces.

In order to determine if the ball-bearing system exhibited lower friction and was therefore more responsible to the forces, photographs were taken at lower voltages as shown in Figs. 13 and 14. Figure 15 illustrates the motion at still higher voltages.

It may be said that the motion of the disk when supported by a ball bearing is similar to that which takes place with a pivot bearing but of considerably greater magnitude.

Conclusions

Among the various conclusions to be drawn from the present study are the following:

1. The simple assumptions adequately explain the observed motion.

2. The motion can be reduced by (a) not having the electromagnet too near the edge of the disk, and (b) keeping the active area of the permanent magnets as near together as possible and of equal strength.

3. The motion of the meter pivot under no-load condition is in the form of a figure eight and the total travel as taken from the curves is approximately 0.002 in. per cycle or 0.12 in. per second. It is interesting to compare this amount of motion with the amount of motion which takes place between the pivot and jewel as a result of full load on the meter.

In this case the pivot moves up the side of the cup jewel until the forces are balanced by an amount such that the point of contact on the surface of the pivot is at a distance approximately 0.005 in. from the central axis.

Using a full-load speed of 0.4 revolutions per second, this results in a motion of 0.012 in. per second which is only of the order of one-tenth that referred to above. Since the pressure be-

tween pivot and jewel is approximately the same in both cases it may well be argued that the tendency toward wear of the pivot would be roughly ten times as much at no-load as under full-load operation and that the former takes place over an area of the jewel which is directly conducive to light-load inaccuracies. It must also be remembered that these same forces are active when the meter is under load and may therefore contribute to the wear.

An old assumption not wholly in accord with facts was that the amount of pivot wear was roughly proportional to the total number of meter-disk revolutions. The present investigation as applied to the pivot and cup type of bearing tends to indicate that the amount of wear is dependent upon the total number of hours during which the meter is standing idle with only potential applied, plus some function of the total number of revolutions. This might be expressed in the form of an equation as follows:

where $W = f_1(T) + f_2(R) + f_3(T,R)$

W = wear

$f_1(T)$ = Function of the time in hour

$f_2(R)$ = Function of the revolutions

$f_3(T,R)$ = Some unknown function of both time and revolutions since these effects are not wholly independent

It must, however, be stated that the nature of meter-bearing wear is so complex and subject to so many unknown variables that it is quite unsafe to make any arbitrary assumptions except as we may ascertain new facts which would throw more light on the problem and explain a relatively large mass of observations. It is, moreover, interesting to study briefly the behavior of the ball-type bearing under similar conditions of no-load operation. Since there exists no appreciable side thrust under the condition of no load, this bearing may be thought of as no more than a ball between two flat horizontal surfaces.

Under these conditions almost perfect rolling motion is secured with the result that there should be little or no wear. Since on appreciable load there is a combination of rolling and sliding, we may, as before, write the equation for wear as follows:

$$W = f_1(R) + f_2(R,T)$$

to indicate that the wear is almost wholly a function of disk revolutions and time, the latter being necessary to take care of such matters as corrosion, etc. Heretofore it has been the practice to lubricate pivot and cut-type bearings while the ball bearings are not lubricated, although lately some manufacturers have recommended against oil in either type.

In this respect the conclusions to be drawn from the present investigation point clearly to the fact that without lubrication and under similar conditions any given alloy will perform better in a ball-type bearing than as a pivot type as related to watthour meters. This conclusion appears to be completely supported by experimental evidence.

Power Plant Records

Records are the engineer's most valuable guide. They need not be elaborate but must show the data needed for the plant in question in a form which is usable. The small plant system outlined below requires about 90 min. a day to keep up, including reading the meters and changing the charts.

By B. H. WHITEHOUSE
Engine-man in Charge
The Milwaukee County House of Correction
Milwaukee, Wis.

ASIDE from the continuity of service, cost of operation in relation to output is of prime importance and it is my belief that many power plants, which have long since been shut down, would still be operating if the chief engineer had been armed with adequate records and reports.

Many engineers contend that reports require too much time, that the accounting department does not cooperate, etc. As to the first, the record system described below, and developed for the Milwaukee County House of Correction Power Plant, requires a negligible amount of time. The clerk in this power plant is an inmate of the institution with no previous power plant experience and after a few days instruction, changes all recording charts, reads all meters, makes the calculations, and types the reports each morning in less than 1½ hr. I consider this the most profitable time spent in the power plant, because it tells definitely what the plant is doing, and any deviation from the general daily outcome of operation can be analyzed and rectified at once.

As to the second objection, there is no question but that the full cooperation of the accounting department is desirable for the dollars and cents are important and probably the standard by which performance is finally measured. From the engineer's standpoint, however, the records can just as well be, in many cases should be, kept on the basis of tons of coal, gallons of oil, pounds of packing, etc. These figures show the performance and operation of the plant, serve to answer any questions that may come up and can be easily converted into dollars and cents when occasion arises.

The power plant for which the following set of records were de-

Table I. Complete data on each piece of equipment is kept on an index card in this way

PUMPS-BOILER FEED NO. 2

DAYTON-DOWD COMPANY QUINCY, ILL.
Centrifugal Pump, Size 1-1/2" CSD Serial No. 37662
GPM 55 Head 415 feet
Speed 3600 RPM. Gland Packing 7/16"

Directly connected to

MURRAY-STANDARD TURBINE Manufactured by
MURRAY IRON WORKS BURLINGTON, IA.
Machine No. 1369, H.P. 14/15 RPM 3600
Steam Pressure 160 lb., Back Pressure 4 lb.
Shaft Gland Packing - Carbon
Completed installation on 5-14-38
Machine put in operation at 8:00 A.M. on 5-14-38.

Table II. This summary for a period of 5 yr. shows the coal and oil used annually, the total steam produced and the comparative overall performance of the plant. The summaries are made up from the complete yearly report shown by Table III

COAL AND STEAM

	1935	1936	1937	1938	1939
On hand Jan. 1st, tons	105	144	1014.27	610.134	85.935
Received during month, tons	6264	6404.31	4955.635	4811.980	5154.445
Total for month, tons	6369	6548.31	5949.903	5422.114	5240.380
Used in Power House, tons	6075	5382.45	5165.16	5162.625	4881
Used at Farm, tons	150	151.59	174.609	169.917	125.109
Used at W.P.A., tons				3.637	
Total used, tons	6225	5534.04	5339.769	5336.179	5006.109
Steam output, lb.	91,467,230	93,686,401	87,069,260	84,209,180	90,859,000
Evap., lb. of water per lb. of Coal	7.52	8.7	8.428	8.156	9.307

OIL

	1935	1936	1937	1938	1939
Steam Cylinder, gal.	868	711	620	549.75	597.65
Stoker, gal.	171	95	221	200.5	174
Engine, gal.	587	223	295	186.9	173.75
Ice Machine, gal.	172	45	53	30.2	44.5
Total in gallons	1798	1074	1189	967.35	989.90

veloped supplied electric power, refrigeration, and steam for heating, cooking and process work for the institution, including the chair factory and the farm. It is equipped with: four 410 hp. stoker fired boilers; five d.c. generators; one 12 t. steam driven refrigeration unit supplying both ice and cold storage; necessary pumps and auxiliary equipment; and a machine shop in the power plant department. This plant is operated by inmates of the institution under the supervision of licensed enginemen (one each shift), and a foreman in the machine shop. Thus we have a low labor charge which does not, however, lower the standard of performance as can be seen from the records.

Records developed for this plant include the following: First, the daily power house report, Table IV, which is self explanatory, with data taken from recorder charts or calculated. December 31, 1938, was a Saturday with the factory shut down and no prison power used, consequently these are left blank.

Second: the monthly report is a summary of the daily reports of any given month and is taken from the column headed "To date" on daily report of the last day of the month. Other values obtained from averaging temperatures and from a card index which will be explained later.

Third: the annual report is merely a combination of the totals of 12 monthly reports, giving all values for a complete year.

Fourth: the annual summary is a report of the most important items with which the accounting department is concerned. In this power plant it is the fuel, oil and the steam output. In the 5 yr. shown it will be noticed that there was a material decrease in fuel and oil consumption with the exception of 1938, while the steam output stayed about the same. These reductions were possible because of plant improvements made from time to time. The items in this summary must coincide with the same items of the same date in the accounting department and may be extended to include any

Table III. Complete annual report for 1939. A similar report is made for each month of the year. The totals for these monthly reports are taken largely from the daily reports on which the cumulative totals are carried forward as shown by Table IV. Data for the items not shown on the daily reports are taken from auxiliary records kept on index cards similar to that shown by Table I. Coal, oil, and wiper records are kept in this way.

COAL	TONS
Consumed in Power House	4881
Consumed at Farm	125.109
Receiver in 1939	5154.445
On hand Jan. 1, 1939	85.935
Total	5240.380
Total used	5006.109
Balance on hand January 1, 1940	234.22
Feed Water consumed in 1939	92,691,000
Steam output for 1939	90,859,000
Average daily temp.	51°
Evap. per lb. coal	9.307

ENGINE SERVICE	HOURS
A.	1600
B.	1704
C.	5485

COAL CONSUMPTION

Month	Tons
January	643.240
February	606.000
March	563.500
April	471.762
May	320.812
June	302.775
July	278.475
August	287.700
September	276.100
October	368.635
November	405.040
December	462.070

ELECTRICAL DISTRIBUTION

	KW-HR.
Factory Light	4970
Factory Power	129000
Prison Light	71060
Prison Power	3800
Kitchen	164050
Griddle	16150
Unmetered	206506
Total	595436

REFRIGERATION DISTRIBUTION

	Ice-Lb.	Ref. Tons
Admin.	21,780	16.752
Res.	21,840	16.652
Matron	7,080	5.336
Farm	15,180	11.638
Kitchen	3,000	1612.147
Total	68,880	1662.525

OIL CONSUMPTION IN GALLONS

Name	P.H.	Req.	Total
Steam Cyl.	597.65	2	599.65
Stoker	174	2	176
Engine	173.75	18.25	192
Ice Mach.	44.5	14	58.5
Kerosene	116.	299	415
Total	1126.90	335.25	1462.15

BOILER SERVICE

	HOURS
No. 1	1848
No. 2	2308
No. 3	5352

COLORED WIPERS IN POUNDS

	P.H.	Req.	Total
Used	1345	410	1755
Pounds			

Table IV. Daily report form. Totals for each day in the first column are taken from meters, charts and operating logs kept by the engineers and firemen. Cumulative totals for the month, shown in the second column, are found by adding the previous day's totals. The third column is filled in only on the last day of the month. It is the cumulative total for the year. The report shown gives a breakdown of the Table II summaries for 1938, much as Table III does for 1939.

DAILY POWER HOUSE REPORT — SATURDAY, DECEMBER 31, 1938

ELECTRICAL DISTRIBUTION IN KW-HR.

	Day	To Date	This Year
Factory Light		940	4849
Factory Power		8300	85720
Prison Light	270	8540	89920
Prison Power		250	3000
Kitchen	450	14740	159390
Griddle	60	1640	22180
Unmetered	694	19571	197043
Total	1474	53981	562102

GENERATOR HOURS

	Day	To Date	This Year
A.		154	1691
B.	13	255	2073
C.	11	359	5109

REFRIGERATION

	Ice in Pounds			Refrig. in Tons		
	Day	To Date	This Year	Day	To Date	This Year
Admin.		720	21800		.552	16.750
Res.		1500	20280		1.150	15.548
Matron	60	1860	18280	.046	1.426	14.030
Farm		420	27200		.322	20.930
Kitchen			4860	2.471	103.943	1550.023
Total	60	4500	92420	2.517	107.393	1597.281

COAL - WATER - STEAM

	Day	To Date	This Year	Day	To Date	This Year
Coal, lb.	51,000			25.5	613.250	5162.725
Water, lb.	424,000	10,089,000				86,696,310
Steam, lb.	420,000	9,977,000				84,209,180
O.%.Temp., F	15					
Steam Pres., lb.	110					
F.W.Temp., F.	201					
Evap. per lb.	8.23					

DAYS SINCE BOILERS CLEANED

No. 1 26 No. 2 42 No. 3 87

ENGINEERS

	On Duty	Off	Vacations	Sick
Chief Engineer	Insp.Trip Only	B.H.Whitehouse		
1st "	Wm. Luenseburg	Wm. Long		
2nd "	J. Clancy			
3rd "	O. Wright			
Machinist	None			
Guard	H. Steiner	1/2 Day		

of the items of the regular annual report.

In addition to these reports we have an engine room log on which the oiler of each shift records meter readings, temperatures, and other useful information. Also a card index, Table I, bearing identification letters or numbers of each machine, together with the name plate information, packing sizes, other available information including when and what repairs are made. Similar cards for coal and oil data are used for reference when making monthly reports.

Records are kept in two loose leaf binders of a size convenient for typewriter use so that any group of reports may be had quickly and easily. This binder also contains space for the records of boiler tests and other data. A typewriter is desirable as it does a much better job than any long hand system.

Equipment necessary to maintain a record of this kind includes electric meters on as many department circuits as possible, flow meters on each boiler, a boiler feed water meter, scales for weighing coal, recording feed water thermometer, recording pressure gage on steam header, and stroke counters on reciprocating pumps and variable speed compressors. Manufacturers of the equipment in use will cooperate in the calculation of constants to be used as multipliers or divisors in the calculation of the values recorded in the reports. While these calculated values may not be absolute, they are entirely practical for giving a comparative figure on operation.

Flood Control Pumping Stations

AMONG OTHER flood control projects being built under the direction of the U. S. Engineer Department, Louisville (Ky.) District are two pumping stations in southern Indiana intended primarily to take care of drainage when the river level is sufficiently high to interfere with the normal natural drainage. The area served consists of approximately 18,000 a. on the Wabash River between Riverton and Carlisle, Ind.

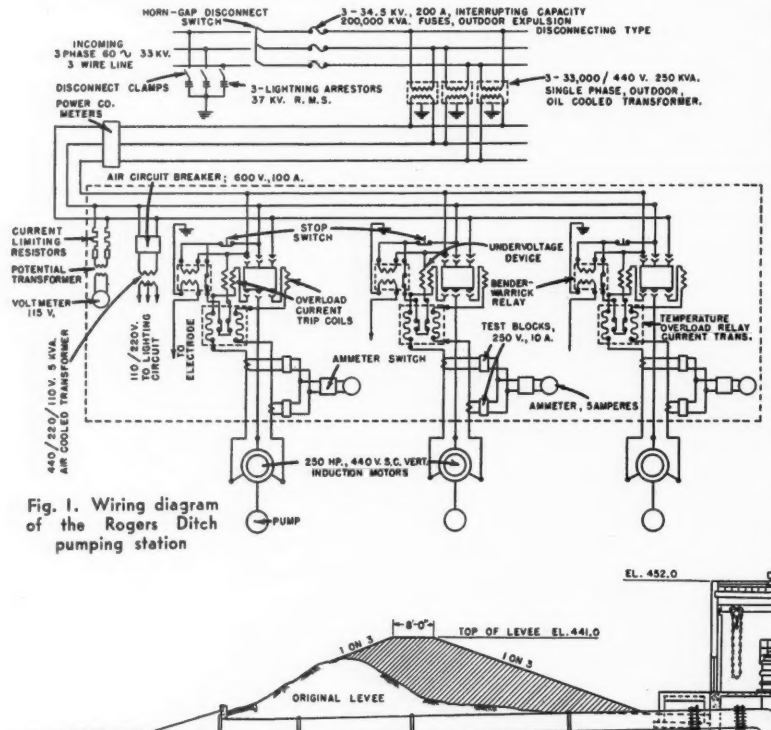

HORN-GAP DISCONNECT SWITCH
3-34.5 KV., 200 A, INTERRUPTING CAPACITY 200,000 KVA. FUSES, OUTDOOR EXPULSION DISCONNECTING TYPE
INCOMING 3 PHASE 60 ~ 33 KV. 3 WIRE LINE
DISCONNECT CLAMPS
3-LIGHTNING ARRESTORS 37 KV. R.M.S.
3-33,000/440 V. 250 KVA. SINGLE PHASE, OUTDOOR, OIL COOLED TRANSFORMER.
POWER CO. METERS
AIR CIRCUIT BREAKER; 600 V., 100 A.
CURRENT LIMITING RESISTORS
POTENTIAL TRANSFORMER
VOLTMETER 115 V.
STOP SWITCH
UNDERVOLTAGE DEVICE
BENDER-WARRICK RELAY
OVERLOAD CURRENT TRIP COILS
TEST BLOCKS, 250 V., 10 A.
TEMPERATURE OVERLOAD RELAY CURRENT TRANS.
AMMETER SWITCH
AMMETER, 5 AMPERES
110/220 V. TO LIGHTING CIRCUIT
TO ELECTRODE
440/220/110 V. 5 KVA. AIR COOLED TRANSFORMER
250 HP., 440 V. S.C. VERT. INDUCTION MOTORS
PUMP

Fig. 1. Wiring diagram of the Rogers Ditch pumping station

The Turtle Creek Pumping Station, which has been recently constructed, has a total capacity of 64,000 g.p.m. at 24.5 ft. head provided by two 36 in. Pomona vertical axial flow pumps, each driven by a 250 hp., 3 ph., 60 cycle, 440 v. Westinghouse motor, vertically connected.

Rogers Ditch Station will have a total pumping capacity of 120,000 g.p.m. at a head of 21.2 ft., provided by three 42 in. pumps driven by 250 hp. motors. The two stations are similar except for the number and size of pumping units. Both stations have a reinforced concrete substructure and brick superstructure. The electrical diagram, Fig. 1, and the sectional elevation, Fig. 2, are, however, for Rogers Ditch, a little over 2 mi. down the river from the Turtle Creek plant. Under normal low water conditions, drainage will bypass the pumping station and drain to the river through corrugated iron pipes equipped with automatic flood gates designed to close under a differential head of 6 in. of water.

In addition to the stations, the project involves the construction of some 6½ mi. of 33 kv. transmission lines from the Indiana Public Service Co. highline west of Riverton, south to the pumping plants. The several contracts involved were awarded separately to the Midland Constructors, Inc., of Chicago and total approximately $117,300. When completed the stations will be turned over to the local levee commission with headquarters at Sullivan, Ind.

Two additional pumping plants involving city storm sewer systems are also under way, at Tell City, Ind.

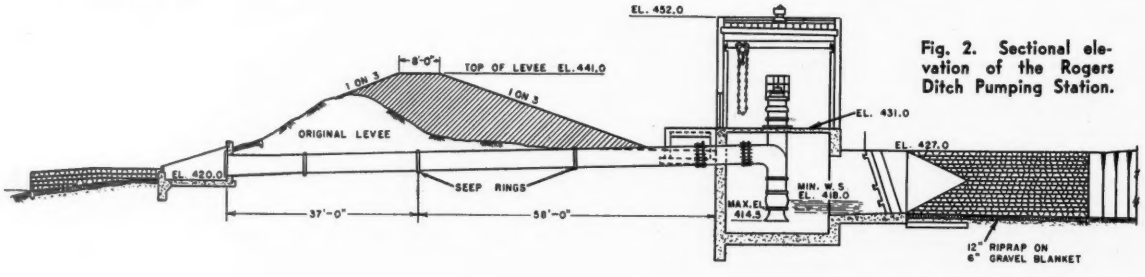


Fig. 2. Sectional elevation of the Rogers Ditch Pumping Station.

Turbine Expansion Lines For Estimating Purposes

By W. F. FISCHER[1]

GENERALLY ACCEPTED as a standard of comparison for the performance of steam engines and turbines, the Rankine cycle is one in which steam is admitted at constant pressure and then expanded isentropically to, and finally exhausted at, some lower pressure. An adiabatic process is one in which no heat change takes place from an outside source and any energy change takes place as work and must be added to or subtracted from the internal energy. An isentropic is a special reversible adiabatic (non-frictional) at constant entropy and makes available for work the greatest amount of internal energy.

Inasmuch as a horsepower hour represents 2546 B.t.u. the indicated water rate of an ideal Rankine cycle engine (or turbine) can be readily calculated as

$$W = 2546 : (H_1 - H_0)$$

Where

W = indicated water rate in lb. per hr.

H_1 = total heat content at throttle pressure in B.t.u. per lb.

H_0 = total heat content at exhaust pressure in B.t.u. per lb.

Assuming an initial steam pressure P_1 entering the first stage as 350 lb. per sq. in. abs., 700 deg. F. (about 268 degrees of superheat) the expansion down to a condenser pressure of 1 in. of mercury (29 in. vacuum) would be represented on the Mollier diagram by the heavy vertical line 1, 2, 3 of Fig. 1. The available heat drop at constant entropy, H_1—H_3, is equal to 1365.6—890.6, or 475 B.t.u. per lb., giving a water or steam rate of 2546 ÷ 475 or approximately 5.36 lb. per hr. The quality of the steam, Q_3, at condenser pressure, Point 3, would be about 80.4 per cent, or in other words the steam would contain about 19.6 per cent moisture.

Only in the ideal turbine, of 100 per cent Rankine cycle efficiency, is it possible to have the expansion of the steam take place at constant entropy. In the actual turbine, the useful work that may be done by the expanding steam is decreased considerably by the transfer of heat which occurs during admission, fluid friction, turbulence, etc.

The Actual Turbine

The overall internal efficiency of the actual steam turbine may vary between 80 and 85 per cent of the Rankine cycle efficiency in carefully designed and well constructed machines; and the "stage-efficiency" is seldom the same throughout, being higher in the superheated than in the saturated field, and decreasing somewhat with an increase in the moisture content of the steam at the lower end.

In the actual turbine, the entropy increases. As a result, the exhaust steam has more energy than it would in an ideal machine. The losses which occur in the turbine, due to steam friction, etc., reappear again as heat in the steam and thus tend to improve its quality or dryness. As a result the specific volume of the exhaust steam is somewhat greater and the final heat content somewhat higher. The stage-efficiency, Q_s, is the ratio of heat converted into work to the theoretical heat-drop or heat available for the pressure stage under consideration.

If, for convenience in estimating, we assume the efficiency of all stages to be equal, and that the internal efficiency of the machine is, say, 83 per cent of the Rankine cycle efficiency, then only 83 per cent of the total available heat drop will be obtainable in practice. The useful or expected heat drop will, therefore, be reduced to 0.83 x 475 or 394 B.t.u. per pound of steam passing through the turbine. The final heat in the exhaust will be 1365.6 —394 or 971.6 B.t.u. per pound, as shown at Point 5, and the quality, 0.881, a material decrease in moisture. The steam rate is 2546 ÷ 394 or 6.46 lb. per i.h.p. hr.

Due to the heat developed within the working substance, from the mechanical action of the steam itself, the exhaust steam contains approximately 7.7 per cent less moisture than with the ideal engine. An approximation of the turbine expansion or condition curve is represented on the Mollier diagram, Fig. 1, by the broken line 1, 4, 5.

Plotting the Condition Curve on the Mollier Diagram

As already mentioned above, the stages of the actual turbine

[1]W. F. Fischer, the author of this article, died suddenly at his home in Woodhaven, N. Y., on April 16. Practically his entire life was spent in the design, construction and operation of power plants with such well known concerns as M. W. Kellogg & Co.; New York Edison Co., New York Steam Corp., J. G. White Eng. Corp., W. Beckers Aniline & Chemical Co., the Combustion Engineering Co. and in private practice as a consulting and contracting engineer on power, heating and ventilating plants. He retired from active practice about 2 yr. ago but continued to keep in close touch with the field until the time of his death.

Table I. Calculations involved in locating points on the condition curve, Fig. 3. The points are located more accurately on the diagram when both the heat content h_s and entropy S_s are determined

Point on Cond. Curve	Init. Pres. P_1	Init. Spec. Vol. V_1	P_s in Super-heat Region	V_s by Eq. 5	h_s at P_s and V_s	Entropy h_s at P_s and V_s	Temp. t_s at P_s and V_s
(1)	350	1.9	....	1.9	1365.6	1.6564	700
A			200	2.9729	1308.2	1.6634	573.6
B			120	4.4736	1261.8	1.6705	470.2
C			70	6.8854	1218.3	1.6788	373.2
D			40	10.7736	1178.4	1.6880	286.2
(6)			32.315	12.7788	1165.3	1.6931	255 (Sat.)

working in superheated steam are more efficient than those working in saturated steam. Actual tests on the Parsons straight-reaction-type turbines show the stage efficiencies in the superheated field to be approximately 10 per cent greater than in the saturated field; and an increase in the moisture content of the steam in the saturated field is accompanied by an additional decrease in stage efficiency, given by Blowney and Warren (The Increase in Thermal Efficiency Due to Resuperheating in Steam Turbines, Trans. A.S.M.E., 1924) as 1.15 per cent for each one per cent increase in the moisture content.

Taking this into account, an approximation of the actual condition curve for this type machine would be represented by the heavy solid line 1, 6, 7, Fig. 1. In this case, the pressure drop in the wet steam region, from Point 6 on the saturation curve to the end Point 7 on the condenser pressure line, is found to be somewhat greater than it is between Points 4 and 5. Following the method proposed by C. C. Franck (Trans. A.S.M.E., 1929) the pressure P_6 at Point 6 crossing the saturation line, may be found by substituting the proper values in the following equation:

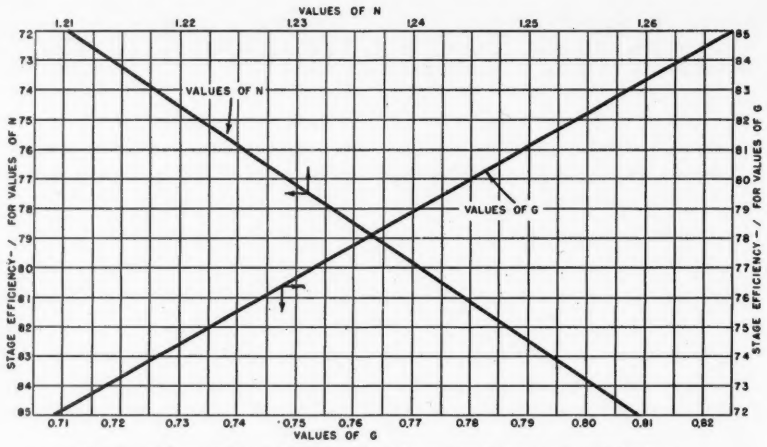


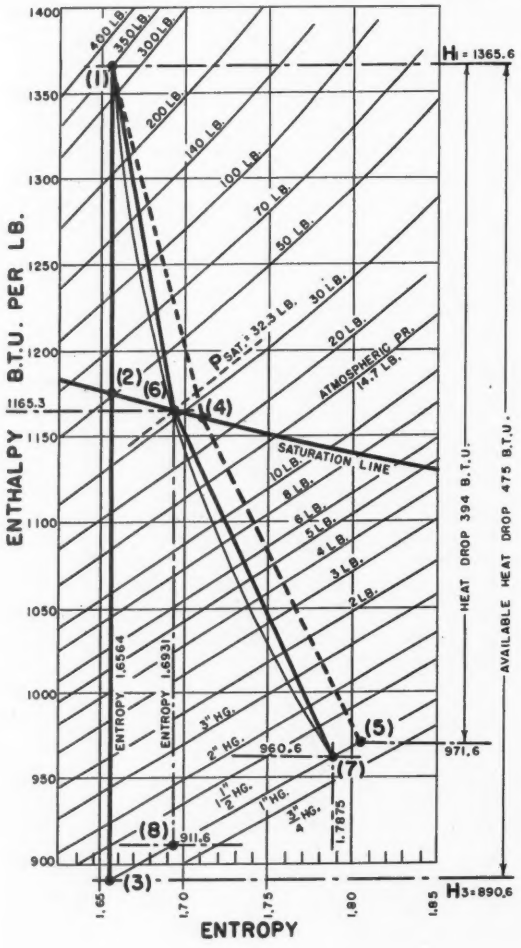
Fig. 2. Values of N and G for calculations involving stage efficiencies

$$P_6 = \left(\frac{333.4}{P_1^{1/N} \times V_1}\right)^{\frac{1.067\,N}{N-1.067}} \qquad (1)$$

Where

P_1 = the initial pressure in lb. per sq. in. abs. entering the first stage (350 lb. t_1 = 700 deg. F.)

V_1 = the specific volume in cu. ft. per lb. at the given



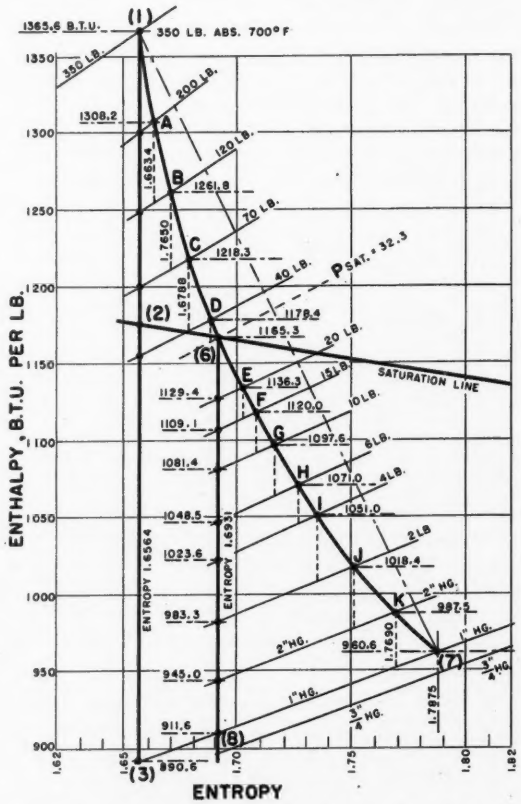


Fig. 1. (left) A section of the Mollier Chart showing the ideal expansion line and several approximations of actual expansion lines

Fig. 3. (above) The turbine expansion line as calculated with due consideration given to differences in stage efficiency

Table II. Tabulations of calculations for locating condition curve for Fig. 3 in the wet steam region

Points on Cond. Curve	Sat. Pres. P_6 at Point 6	B.t.u. per lb. at Point 6	Final Pres. P_f in wet steam region	B.t.u. per lb. at Rankine Drop to $P_f = h_c$	Rankine Heat Drop, H_r B t.u.	Useful Heat Drop $0.807 H_r$	B.t.u. per lb. h_f	Entropy of Steam S_f	Quality of Steam Q_f
				At Constant Entropy, 1.6931			At given point on Condition Curve		
(6)	32.3	1165.3	..	1165.3	0	0	1165.3	1.6931	1.000
E			20	1129.4	35.9	29.0	1136.3	1.7039	0.980
F			15	1109.1	56.2	45.3	1120.0	1.7089	0.968
G			10	1081.4	83.9	67.7	1097.6	1.7184	0.954
H			6	1048.5	116.8	94.3	1071.0	1.7295	0.937
I			4	1023.6	141.7	114.3	1051.0	1.7377	0.924
J			2	983.3	182.0	146.9	1018.4	1.7525	0.904
K			2" Hg.	945.0	220.3	177.8	987.5	1.7690	0.886
(7)			1" Hg.	911.6	253.7	204.7	960.6	1.7875	0.871

pressure P_1 and temperature t_1 ($V_1 = 1.8997$).

N = the coefficient of expansion, depending upon the stage efficiency (1.252 for 83 per cent stage eff.—See Figure 2.

This exponential eq. (1) can be solved by logarithms and log P_6 is:

$$\frac{1.067\,N}{N-1.067} \times \left[\log 333.4 - \left(\frac{1}{N} \times \log P_1 + \log V_1\right)\right] \quad (2)$$

For the conditions given above, log P_6:

$= 7.221\ [2.52297 - (0.8 \times 2.54407 + 0.27869)] = 1.5940$

or $P_6 = 32.3$ lb. per sq. in. abs.

The total heat content of the saturated steam at this pressure is found, by interpolating in the steam tables, to be approximately $H_6 = 1165.3$ B.t.u. per lb.

Having thus found P_6 and H_6 we can locate Point 6 (Fig. 1) on the saturation curve. A straight line joining Points 1 and 6 will be an approximation of the true condition curve in the superheated region—above the saturation line.

The entropy, S_6 of saturated steam at 32.3 lb. per sq. in. abs., is found to be 1.6931; and steam at this pressure, when expanded at constant entropy to the condenser pressure of 1 in. Hg. contains about 17.6 per cent moisture and has approximately 911.6 B.t.u. per lb. The available heat drop, (Point 6 to 8) is, therefore, 1165.3 — 911.6, or 253.7 B.t.u. per lb. This is referred to as the Rankine-drop for the conditions given, and must be multiplied by a coefficient G, which, for a stage efficiency of 83 per cent in the saturated region, is from Fig. 2 equal to 0.807. Hence the heat content H_7 at the end. Point 7 on the 1 in. line, is equal to

1165.3 — (0.807 x 253.7)
or 960.6 B.t.u. per lb.

The entropy, S_7, of the vapor corresponding to this heat content is 1.7875, and the quality, 0.871 per cent. A straight line joining Points 6 and 7 is an approximation of the true condition curve in the wet steam region for the steam conditions given above.

Rounding Out the Condition Curve

Although the approximate curve 1, 6, 7 of Fig. 1, may be quite satisfactory for ordinary estimating purposes, the pressure at the bleeder or extraction points can be determined more accurately by rounding out the condition curve. In the method proposed by Mr. Franck, it is assumed that the expansion in the superheated field takes place according to the relation.

$$V_a = V_1 \left(\frac{P_1}{P_a}\right)^{1/N} \quad (3)$$

Where N and P_1 and V_1 are the same as before and P_a is any pressure lower than P_1 and V_a is the specific volume corresponding to P_a.

This may be conveniently calculated as log V_a

$$= \log V_1 + \frac{1}{N}(\log P_1 - \log P_a) \quad (4)$$

Taking $P_1 = 350$, $V_1 = 1.9$, and $N = 1.252$, Eq. 4 may be written

$$\log V_a = 2.31401 - 0.8 \log P_a \quad (5)$$

Taking pressures in the superheated region, as shown on the Mollier diagram, Fig. 3, the work may be tabulated as shown in Table I and intermediate points A, B, C, D located on the diagram accordingly. A smooth curve drawn through these points will represent the condition curve in the superheated steam region of the diagram.

In order to locate the points in the wet steam region, the effect of the decreasing stage efficiencies must be taken into account. Due to the increasing moisture content in the expanding steam, it is rather difficult to determine a true average stage efficiency for the entire expansion in the wet steam region but the intermediate points may be determined in a manner similar to that already employed in locating the end Point 7 of Fig. 1.

Several values of the Constant G which take into account the decreasing stage efficiencies as the moisture content in the steam increases are given in Fig. 2. Taking G = 0.807, as before, and assuming the pressures, the computation may be tabulated as shown in Table II.

Table III. A section of the steam tables showing the thermodynamic properties of superheated steam as used in the calculations.

Abs. Pres.	Sat. Temp. Deg. F.		Sat. Liquor	Sat. Vapor	Temperature t, deg. F. 460	500	560	600
		V	0.018	3.728	4.418	4.636	4.955	5.165
120	341.25	h	312.4	1190.4	1256.5	1277.2	1307.6	1327.7
		S	0.4916	1.5878	1.6649	1.6869	1.7177	1.7370
		V	0.018	2.288	2.585	2.726	2.928	3.060
200	381.79	h	355.4	1198.4	1246.5	1268.9	1301.1	1322.1
		S	0.5435	1.5453	1.6001	1.6240	1.6566	1.6767

Table IV. The bold face portion of Table V for 120 lb. with the nomenclature used in the calculations for interpolation

$V_x = 4.418$	$V_a = 4.4736$	$V_y = 4.636$
$h_x = 1256.5$	$h_a = 1261.8$	$h_y = 1277.2$
$S_x = 1.6649$	$S_a = 1.6705$	$S_y = 1.6869$
$t_x = 460$	$t_a = 470.2$	$t_y = 500$

Interpolating from the Steam Tables

Referring back to Table I we find that after obtaining the specific volume V_a, as set down in the fifth column, it is necessary to determine the corresponding unit heat content h_a of the superheated steam at the given pressure P_a and Volume V_a. The intermediate points on the diagram can be located more accurately if the

entropy of the steam, S_a, at the given pressure and volume is also known. These values, h_a and S_a respectively, as well as the temperature t_a, can be found from the steam tables by interpolation.

Values given in Table III have been taken from the Keenan and Keyes Steam Tables for the purpose of illustration. Had this table been extended to include the value h_a (enthalpy) and S_a (entropy) for the value $V_a = 4.4736$ for 120 lb. abs. pressure, these values would be between the two columns printed in heavy type. Interpolation can be facilitated by tabulating these dark values of Table III as shown by Table IV. In this case $V_a = 4.4736$ and it is necessary to find h_a, S_a and t_a.

$$h_a = \frac{(V_a - V_x)}{(V_y - V_x)} \times (h_y - h_x) + h_x \qquad (6)$$

$$\frac{(V_a - V_x)}{(V_y - V_x)} = \frac{0.0556}{0.2180} = 0.255$$

So that $h_a = (0.255 \times 20.7) + 1256.5 =$ 1261.8 B.t.u. per lb.

Similarly, $S_a = 0.255\,(S_y - S_x) + S_x$
$= (0.255 \times 0.022) + 1.6649$
$= 1.6705$

and $t_a = 0.255\,(t_y - t_x) + t_x$
$= (0.255 \times 40) + 460 = 470.2$ deg. F.

Values of h_a, S_a, and t_a for the other final pressures P_a as given in Table I, can be found in the same way.

The method followed when interpolating for the values h_f, S_f and Q_f respectively, in the wet steam region, as given in the last three columns of Table II, is somewhat different than that outlined above. The values h_c, as given in the fifth column, are B.t.u. per lb. of steam at the given pressure P_f, for a constant entropy equal to 1.6931 in each case. For a pressure P_f equal to 20 lb. abs., the value of h_c is given as 1129.4 B.t.u. per lb. with entropy equal to 1.6931. This value of h_c is found from the saturated steam table by the procedure outlined below. Dry saturated steam at 20 lb. abs. pressure has the following thermodynamic properties:

Enthalpy of the liquid = 196.16 B.t.u. per lb. $= h_t$

Enthalpy of evaporation = 960.1 B.t.u. per lb. $= h_e$

Enthalpy of the vapor = 1156.3 B.t.u. per lb. $= h_v$

Entropy of the liquid = 0.3356 $= S_t$

Entropy of evaporation = 1.3962 $= S_e$

Entropy of the vapor = 1.7319 $= S_v$

Quality, Q_c, at a pressure $P_f = 20$ and entropy of 1.6931 is

$$Q_c = (1.6931 - S_t)/S_e$$
$$= (1.6931 - 0.3356)/1.3962$$
$$= 0.972$$

and

$$h_c = (Q_c \times h_e) + h_t$$
$$= (0.972 \times 960.1) + 196.16$$
$$= 1129.4 \text{ B.t.u. per lb.}$$

The Rankine drop, H_r is therefore 1165.3 — 1129.4 = 35.9 B.t.u., as given in the sixth column of Table II, and the useful or expected heat drop, H_r 29 B.t.u., as given in the seventh column. The value h_f at point E on the condition curve, of Fig. 3, is then equal to 1165.3 — 29 = 1136.3 B.t.u. per lb. The quality, Q_f of the steam at this point on the diagram, as given in column 10 of the table, is found to be:

$$Q_f = \frac{h_f - h_t}{h_e}$$
$$= \frac{1136.3 - 196.16}{960.1}$$
$$= 0.98 \text{ or } 98 \text{ per cent}$$

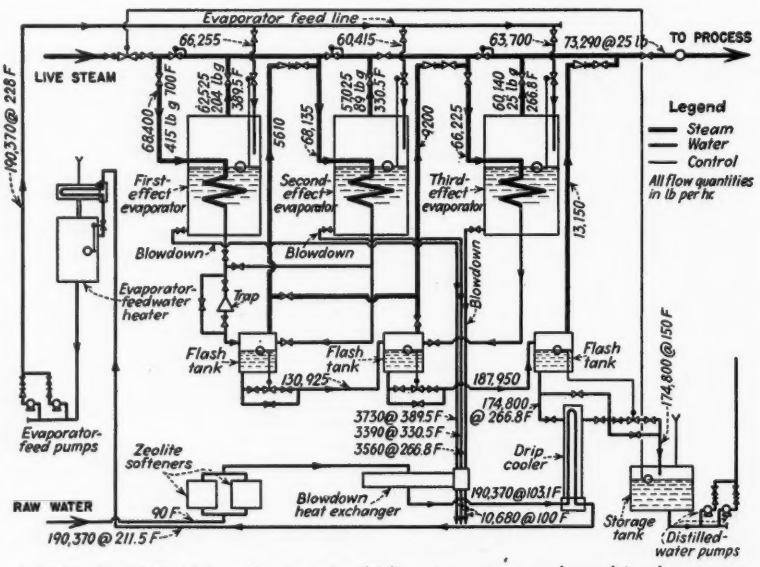
and the entropy, as given in the ninth column of the table,

$$S_f = (Q_f \times S_e) + S_t$$
$$= (0.98 \times 1.3962) + 0.3356$$
$$= 1.7039$$

Values of h_c, h_f, S_f and Q_f for other pressures, P_f, can be found in a similar manner. Values obtained from the steam tables in the manner described above are far more accurate than those picked from the diagrams accompanying the steam tables.

Evaporator Heat Balance

INDUSTRIAL EVAPORATORS, often called heat transformers, are in more or less common use for supplying considerable quantities of process steam which is either lost or so badly contaminated that the return is not suitable for high pressure boiler feed. The accompanying heat balance shows a Foster Wheeler triple effect evaporator of this type installed in the Front Royal, Va., rayon plant of the American Viscose Corp. The 25 lb. steam for process augments steam extracted from the turbines. The viscose process requires a constant supply of electric power for spinning machines, motors and refrigeration, low pressure steam for drying, and hot water for washing and bleaching—an ideal process steam and power setup.



A triple effect industrial evaporator using high pressure steam and supplying low pressure process steam and distilled boiler feed makeup

The PRACTICAL ENGINEER and ELECTRICIAN

RALPH E. TURNER, EDITOR

TAKING ON FUEL

Hello Folks: After the build-up Mr. Morris gave me in the June issue, to say nothing of the communications I have had with readers of Power Plant Engineering for the past thirty odd years, I feel that you must know me pretty well—me and my pals in the editorial department. Now, as agreed upon in an editorial huddle a year ago, it becomes my turn to carry on the work of editing the Practical Engineer and Electrician so ably done by my predecessors.

That there will be something of a change of pace, goes without saying, but it will seem only a short time until Mr. Kramer will be conducting these pages again, and then Mr. Morris. In the meantime these editors will be devoting their energies to the gathering of engineering data and its presentation in Power Plant Engineering.

At the time of this writing, Mr. Kramer is working along the east coast where he has attended the Edison Electric Institute's annual convention at Atlantic City. Before his return he will also attend a meeting of the National Conference of Business Paper Editors in Washington where rather intimate off-the-record conferences are planned with President Roosevelt, members of the new National Defense Commission, the Secretary of the Navy, the Secretary of War and other Government officials high in national authority. He will also visit a dozen or more power plants and has already reported the gathering of a lot of practical data that will be presented to readers of this magazine.

Readers will also in due season be given valuable information gathered by Mr. Morris who is now touring the southwest from Chicago to California —territory he has traveled many times in the past.

So my turn at the wheel makes it possible for these highly qualified editors to study first hand the problems of the industry and as rapidly as possible report the solutions to you through the pages of this magazine.

R. E. T.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

It's My Job

ON NUMEROUS occasions people have asked me just what the job of an editor of a technical magazine is. The impression seems to prevail that the principal part of an editor's job is the correcting of manuscript submitted by authors for grammar, spelling, punctuation and diction, the abstracting of papers, the rewriting of news releases to fit a definite class of readers, the writing of descriptive articles, the compilation of data and the presentation of this material in pleasing form on the pages of the magazine. All of this is unquestionably the job of an editor, any editor, every editor, of a "tattle" sheet, society bulletin, newspaper, magazine or technical journal. You will note that all of this work with the exception of the presentation on the page calls for but little originality. It may rightly be classed as clerical or routine work, the formal part of the editorial job, the part that has become more or less standard with rules established for guidance.

Is there more to editing than that? Decidedly yes. To explain let me tell of my job which means to a great extent that also of the other editors on the staff of this magazine for we must all work hand-in-glove toward specific ends with overlapping and coordinating duties, each taking turns at various editorial functions, but may I emphasize that just as there are no two human individuals exactly alike, POWER PLANT ENGINEERING as a magazine is distinctly different from every other publication in its editorial presentation. As long as humans are different, it cannot be otherwise for a magazine is strictly a brain product.

The function of an editor of POWER PLANT ENGINEERING and all its departments is the carrying of information to numerous points where it can be advantageously used, from sources not readily available to a majority of its readers. The transportation medium is POWER PLANT ENGINEERING and the receiving points are power plants and engineering offices throughout the entire country. The editor is under contract with the subscribers to keep them posted on the major and the majority of the minor developments in the field of power generation and its use which will assist the reader in his particular line of work. The staff must satisfy the subscribers by providing a sufficient amount of usable material; the value to the reader of the ideas presented must be evident; the closeness with which the articles fit the needs of subscribers, the timeliness of the material, the authenticity of the manuscript and the manner of presentation must all meet with approval.

Personal familiarity with the field and with the professional duties of subscribers are primary essential qualifications of an editor. Serving the field is an art. The interests of engineers are continuously changing. An article published today may not be properly timed to receive the attention it deserves. The field may not yet be ready for that particular type of treatment, or interest may have waned due to many causes. In the matter of timeliness, the editor must be an opportunist, serving readers while their interest is at its peak. People want their soup and coffee hot, their meat and potatoes comfortably warm, and their ice cream cold. Likewise technical magazine articles, to be satisfying, must have the proper psychological treatment—spot news must be used immediately, developments can be brought up-to-date at any time, fundamental information for magazine purposes is the latest text book material and has lasting value but it must have timely interest.

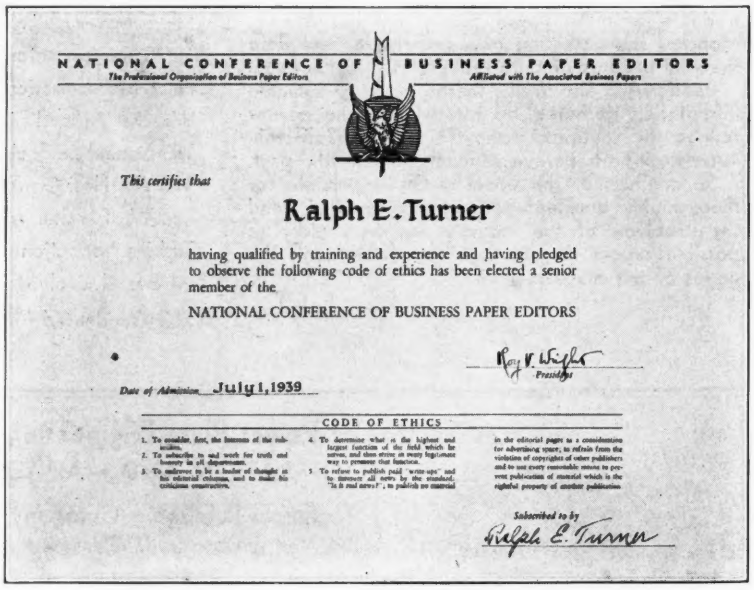
To a magazine serving a highly specialized field, a highly important qualification of an editor is the ability to determine the subjects that need treatment. Here again he must resort to art. He may, of course, secure help through analyses of the subscription list which would give him totals and percentages of persons engaged in various classes of power plant work, but in the end his selection of subjects to be treated must depend upon his judgment of the degree of need for information which he can present on the particular subject. This can hardly be called a scientific procedure.

As to the need of the field, the editor usually "pounds the pavements" to find the answer, using of course a well trained "nose for news" in the specialized field. Some of the avenues open to him are: contact with the men in the field; visits to plants representative of those served by the magazine; attendance at engineering society meetings; calls on manufacturers of power equipment and their representatives; attendance at manufacturing association meetings; questions asked by readers; comments on various topics by readers; manufacturers' interests in specific subjects; trends of thought indicated by published material in outside and general fields; equipment exhibitions; tips from friends in the field. To this must be added the vision or foresight of the editor in predicting the trend of thought and development of equipment that will be used in the field. It is always a source of satisfaction to an editor to be able to write to an engineer asking for information that "you will find the subject fully treated in the last issue of this magazine, tear sheets of which are enclosed."

To supply the needs of readers, the editor must first of all have an appreciation of the problems confronting the field, then familiarize himself with the methods leading engineers are employing to solve their problems. With this as a basis he is in position either to approach a competent author for an article of the particular type he wishes on the subject, or in many cases compile the material himself as a result of his studies and research.

Treatment of subjects must be within the comprehension of the men who are expected to use the material. In many cases where certain scientific principles are just beginning to be applied in the field, the treatment must take the form of a text starting with simple fundamentals and carrying the reader by easy stages through the necessary conceptions to the final application of the principles to his own equipment.

In the course of my daily work I endeavor to keep in my mind's eye a



NATIONAL CONFERENCE OF BUSINESS PAPER EDITORS

The Professional Organization of Business Paper Editors — Affiliated with The Associated Business Papers

This certifies that

Ralph E. Turner

having qualified by training and experience and having pledged to observe the following code of ethics has been elected a senior member of the

NATIONAL CONFERENCE OF BUSINESS PAPER EDITORS

Date of Admission July 1, 1939

President

CODE OF ETHICS

1. To consider, first, the interests of the subscribers.
2. To subscribe to and work for truth and honesty in all departments.
3. To endeavor to be a leader of thought in his editorial columns, and to make his criticisms constructive.
4. To determine what is the highest and largest function of the field which he serves, and then strive in every legitimate way to promote that function.
5. To refuse to publish paid "write-ups" and to measure all news by the standard, "Is it real news?", to publish no material in the editorial pages as a consideration for advertising space, to refrain from the violations of copyrights of other publishers and to use every reasonable means to prevent publication of material which is the rightful property of another publication.

Subscribed to by

Ralph E. Turner

composite picture of each class of subscriber I am endeavoring to serve, the physical conditions surrounding him in his plant, the equipment with which he must work, the dangers he must encounter, his background of education and experience, his employment problems, his age and his health. To these men it is my endeavor to supply all kinds of information that will assist them in their professional work. To serve, may I say, as a sort of private secretary to the subscriber, providing him with the information he needs as he needs it and placing on his desk a report of happenings of the month about which he should know. This service is made available to the subscriber who can extend that service by asking questions or indicating what information is needed in the field and at the same time assist us editors in being helpful to other subscribers in the field.

All of these aims and ambitions which I have enumerated may seem idealistic, as does the Code of Ethics of the National Conference of Business Paper Editors to which I heartily subscribe, and impossible of attainment. Nevertheless, like the 100 per cent efficiency you strive to approach in the operation of your equipment, I as an editor must also have some ideal to keep in mind and the things I have outlined are definitely some of my personal ambitions.

This is my job. It has been for many years. And with all its perplexities, I like it.

RALPH E. TURNER

. . . SHORTS . . .

By adding an adequate trap to the cooking kettles the Elliott Packing Co. of Duluth reduced the cooking time from 8 to 3½ hr. and doubled the capacity of the kettle.

* * *

When ignition is lost on a gas, oil or pulverized coal burner, the fuel should be cut off immediately and the furnace thoroughly purged before lighting up. A drop in steam pressure is preferable to a prolonged visit from the coroner.

* * *

The slang phrase "You aint seen nothing yet" might well be applied to a recent electrical invention. It is known as the "electric nose" and measures an invisible shadow cast by an invisible vapor with an invisible light. That's hard to see, comments the New Jersey Public Information Committee, but it has an important use in plants where mercury is employed because it can detect one part of mercury in a billion parts of air, and sounds a horn when ever mercury is present in the air.

* * *

Eight steps in the modern incandescent lamp are given in a recent issue of the G. E. Monogram: Edison's original lamp in 1879 after 26 prior inventions had failed; Dr. Whitney's metallized carbon filament in 1905 with two hairpin loops in series instead of the horseshoe form; the tantalium filament in 1906; the tungsten filament in 1907; Dr. Coolidge's drawn tungsten filament; Dr. Langmuir's gas filled lamp, 1913; tipless and frosted lamps in 1919; the high efficiency filament lamp of 1938 in which the filament is wound around molybdenum mandrels which are dissolved out by chemicals.

* * *

Ohio is said to be the greatest hot house vegetable growing state, with over 600 a. of vegetables under glass and consuming between 300,000 to 500,000 t. of bituminous coal per year. Conservative estimates run 500 t. of coal annually per acre under glass. How does this check with the experience of some of our own hot house engineer's records? For the sake of comparison comparable degree day data should be included.

* * *

Flat work ironers and other laundry equipment need steam at about 90 lb. pressure for effective operation so that in a laundry steam at about 100 lb. pressure should be available. Approximately 70 per cent of the steam generated by a laundry boiler is required for water heating.

* * *

Many factors influence the water rate of an engine but in general new engines will fall in the following ranges in pounds per indicated horsepower: uniflow, 20-24; four valve, 25-35; piston valve, 30-40; slide valve, 33-60. Costs range in the same order with uniflows the most expensive. In industrial applications when the exhaust steam is used a low water rate is not always necessary for the resulting shortage of exhaust steam may have to be made up by live steam.

* * *

A 3-ply leather belt, 150 ft. long and 4 ft. wide, in constant service in a Minneapolis flour mill since 1884, is said to have had only neatsfoot oil as a dressing.

* * *

Lacing belts with leather or wire requires considerable knowledge and skill while a good job can be done by any careful workman with the hinge type or metallic plate type.

Honors Awarded to J. F. Karney

Outstanding achievements in engineering receive recognition each year by the Greater New York Association Number One of the National Association of Power Engineers when the Robert Grimshaw Medal is awarded. This year the medal was presented to Joseph F. Carney, Building Superintendent of the Waldorf-Astoria, at a dinner held in his honor in The Waldorf on May 25. Mr. Carney started his career as a machinist which led him into the field of erecting machinery and constructing electric power plants. He later served as chief engineer of several hotel plants, then as building superintendent and is now a member of the Board of Directors of the Hotel Waldorf-Astoria Corp. In the photograph he is shown at the left being congratulated by Robert Grimshaw, the ninety year old donor of the medal and Albert H. Morgan, representing Mayor La Guardia, who presented the medal awarded for outstanding achievement and efficiency in engineering.

A Jig to Fit Brushes to Commutators and Slip Rings

By
Eugene George Key
and
M. M. Jennings

IN MANY COMPANIES the practice is to sandpaper new brushes to fit the commutator or slip rings of a motor or generator before the brushes are placed in service. This fitting is usually done on the machine itself, even though this may be inconvenient and even costly. The better method is to fit them by means of a jig which requires only a few minutes to make.

In making this jig, the first step is to measure the circumference of the commutator or rings. A piece of string placed around the commutator or rings, but not stretched, and then measured will give this dimension. Divide this figure by pi (3 1/7 or 3.1416) to get the diameter. Tie a loop in the end of the string, measure the length of the diameter along the string, and tie a knot to mark this distance.

Next, get a piece of wood about 1 ft. long, 6 in. wide, and 2 in. thick. This is to be the jig. Clamp this piece of wood to a table or other convenient place and with the string as a compass and the knot as a center, place a pencil in the loop at the end of the string and strike an arc on the block of wood. Cut along this arc with a saw and you have duplicated the curvature of the commutator or rings.

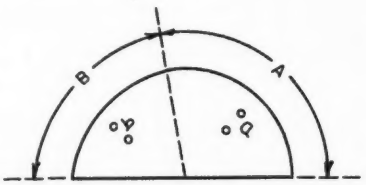
When the wood has been cut to size and shape, the next job is to fit a brush holder to it. Only a spare holder that is made for the particular machine can be used. There are several ways in which a holder can be attached to the jig and any good maintenance man can easily determine the best way to attach the particular one to be used. For that reason no specific directions can be given here. A few suggestions, however, will warn against some errors that can easily be made. The brush holder must be attached at approximately the same angle as those on the machine itself and arrangements must be made so that the assembly can be shifted and then tightened when the brush is being fitted. When the brush holder is attached, the jig is ready for use.

The correct way to use the jig is to put it in a bench vise, take the old brush out of the machine and put it into the holder on the jig, tightening the spring until the brush is held firmly. Then shift the holder until the curvature of the brush surface fits the curvature of the jig as nearly as possible. When this position is found, remove the old brush and put in the new one, adjusting the spring to about the tension that it should have on the motor. Take a piece of sandpaper or emery cloth about 2 in. wide and as long as is available and cut the brush in the same manner as if it were on the machine itself. When the brush is finished, it will have at least a 60 per cent or better contact surface against the commutator or rings on which it is to be used. This surface is all that can be expected when the brushes are fitted on the actual machine.

Advantages of using the jig instead of the machine for fitting the brushes are numerous. Among them are:

1. No carbon dust can wedge itself into the mica between commutator bars or between rings, thus preventing flashovers from this cause. It also saves the necessity of blowing out the machine after the brushes have been fitted.

2. In many motors, there are sharp edges and projections which can knock skin off knuckles of the mechanic. This painful and sometimes dangerous result cannot occur on the jig which is always used in the open where there is plenty of room to work.



A jig for two sizes of rings or commutators. A and B indicate limits of each curvature; a and b are holes for fastening brush holders to the jig

3. The jig has a curvature which is the average of that of the commutator or rings of the motor or generator for which it is to be used. The commutator or rings often have rough spots which may cause a brush curvature that will not even approximate the average curvature if the spot happens to be at or near the brush that is being fitted. This false curvature might reduce the contact surface to from 30 to 50 per cent as compared to the 60 per cent or better possible with the jig.

4. Emery cloth, being made of metal abrasives, is a much better cutting agent than sandpaper. Emery, however, is a conductor of electricity and cannot be used on a motor. It can be used on a jig to speed the brush fitting and cut a better surface on the brush.

5. Projecting parts of a motor often make very difficult the job of sanding brushes there. The writers have required as much as 1 hr. to surface brushes on some machines, yet 5 min. was sufficient for the same machine by use of a jig.

6. One jig can be made up for more than one motor or set of motors if a block of wood longer than one foot is used. The sketch shows a jig which is made up for the slip rings and commutator of a single machine. A and B indicate the range of curvatures and *a* and *b* the holes for fastening the brush holders to the jig. This method could be used for a jig for more than one machine, if desired, and each curvature should be marked to identify the machine for which it is to be used.

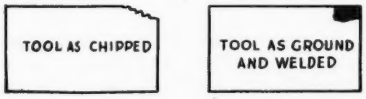
7. Occasionally a brush needs changing on a machine that should not be shut down for more than a very few minutes. In his spare time, the maintenance man can easily make up a full set of brushes for this machine and store them for ready use. When a brush needs changing, the new one can be set in place and the machine put back in service in a few seconds' time.

Reconditioning Tools

FORGING DIES, trimmers, shear knives, punches, cutting tools, etc., can be repaired by welding and the following directions apply specifically to Amsco Dieweld developed recently for this purpose: In reconditioning dies and tools by electric or gas welding, the parts must be ground free of all fire checks, etc. When repairing chipped tools, the chipped portion should be ground to remove possible slivers, and to form a shelf or step to receive the weld metal as shown by the sketch.

The weld is air-hardening as welded and in this condition must be finished by grinding. It can then be machined as easily as any ordinary steel. However, if the die or tool is heated to approximately 1400 deg. F., and allowed to cool, either within the furnace or by submerging it in asbestos, mica or some similar insulating material.

To reharden, it is necessary to reheat it to between 1500 and 1800 deg. F., and either air or oil quenched. The average Rockwell "C" Hardness of the weld is between 55 and 60, either as welded or heat-treated.



In applying electrically, the coated rod should always be used, with positive or reverse polarity. The arc length should be equal to the diameter of the rod. On low carbon steel, the current should be kept as low as possible to prevent dilution of the deposit. With oxy-acetylene a neutral flame should be used to bring the metal to a fusion temperature, then readjusted to reducing flame for melting and fusing to the base metal. Excess acetylene should gradually be increased until the metal flows easily and is free from oxide. A tip several drill sizes larger than ordinarily used for carbon steel is desirable to heat the area in the shortest possible time.

Where it is necessary to make large deposits, which ultimately will be machined, preheating is desirable as annealing and heat-treatment will follow the welding and machining. It is also advisable to preheat all die and tool steels before welding to a temperature of 300 deg. F. or higher, but not to exceed a point 50 deg. F. under the normal drawing temperature. By experiment, quenching and drawing temperatures may be controlled to produce desired hardness and toughness in the weld.

Steam Quality

MEASUREMENT of steam quality or the carryover from modern boilers is very difficult because of the small total solids in the steam. An accuracy is required higher than that which can be expected from the steam calorimeter. One possible method is to weigh the residue from the evaporation of a sample of condensate but this becomes increasingly difficult as specifications for steam quality are made more rigorous and, furthermore, it is not suited to continuous observation of performance in order to detect momentary variations.

For this purpose the most desirable method so far found is determination of steam quality by measuring the electrical conductivity of the condensate. While this procedure has certain inherent difficulties, such as the necessity for removal of the dissolved gases of an electrolytic nature, it has been applied satisfactorily in a number of high pressure, modern power stations. A conductivity meter of this kind using a conductivity bridge can be used as a recording instrument.

Top Turbines

WHEN CONSIDERING plant remodeling, high pressure boilers are usually given consideration because of the increased amount of by-producer power available from higher pressure steam. Frequently low pressure engines or turbine generators are in good shape and work in well with the plant needs. In these cases top or superposed turbines can be used to advantage to give the additional electric power needed without increasing the quantities of exhaust steam or making any change in the condenser capacity, auxiliaries or water supply.

While an exact determination of the additional power available can be made only by a close study of old as well as new equipment, the accompanying curves are sufficiently accurate for preliminary estimates. These are based on a 70 per cent Rankine cycle ratio and 150 lb., 450 deg. F. (about 80 deg. F. superheat) low pressure equipment. The ratios change but slightly for a considerable range in low pressure and temperature. Thus a 600 lb. top on a 1000 kw. condensing low pressure turbine would develop 0.35 x 1000 or 350 kw. On a 1000 kw. non-condensing turbine a 600 lb. top would produce 0.71 x 1000 or 710 kw. The difference in the two cases comes about through the fact that the non-condensing low pressure unit has about twice the water rate of a condensing unit so that approximately twice the steam flow would pass through the high pressure turbine.

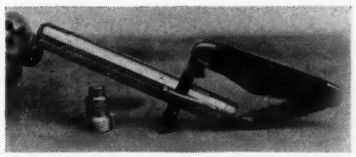
Defrosting Pipe

WHEN THE EVAPORATOR or cooler is arranged so that sections may be cut out, the coils may be defrosted one at a time and permitting the idle coils to warm up while carrying the load on the remaining coils. If time is a factor, the defrosting can be speeded up by passing compressed air through the coils to loosen the ice and frost. This is practical with brine coolers but involves danger of air contamination in direct expansion coils unless the pipe is arranged so that the air can first be pumped out by applying a vacuum to the coil in question.

Light Where You Want It

By Frank Bentley

THE COMMON pen type flashlights are handy to use when both hands must be engaged in some work. A pocket knife will hold the light in almost any position and at the same time keep it

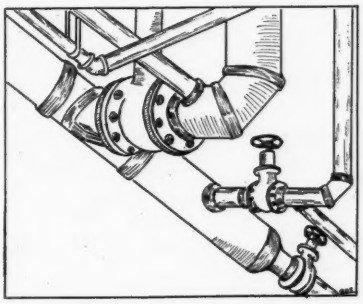


lighted. Push one blade under the pocket clip and force the point firmly into a piece of wood as shown by the photograph. One blade should touch the end of the back dry cell after the switch or button cap has been removed. The light can be held in this manner in almost any position and will throw a steady light exactly where it is needed.

Steam Pipe Welding Job

PIPING for the complete heating system of a 12-story building was recently assembled and welded on the job, including 1985 ft. of pipe. From the 14-in. exhaust headers steam is carried a half block through a tunnel to an 8-in. riser, which runs to the 8th floor; thence distributed by a down and upfeed vacuum system throughout the building.

Machine-beveled piping was used, but special fittings and bends were fabricated and beveled to carefully prepared templates from standard pipe on the job by means of the oxyacetylene cutting blow pipe.

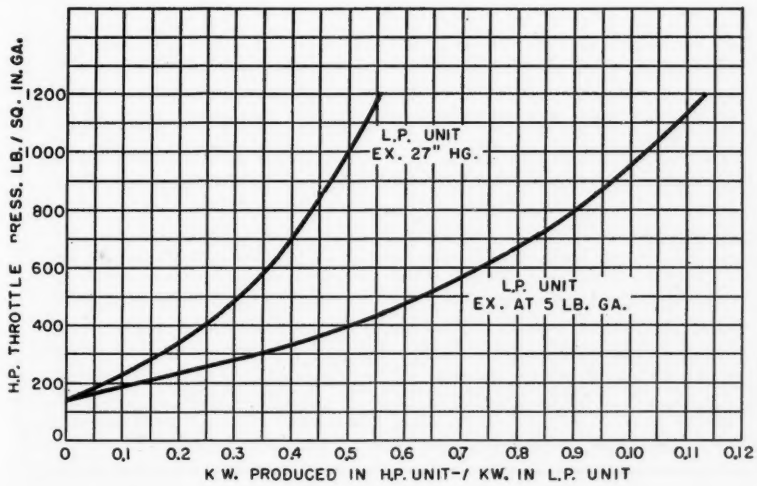


Sections of a convenient size for handling were assembled and welded near the point of installation, then raised to position and tie-in welds made, thus reducing scaffolding needed. Many tie-ins were even made from a ladder. Anchors and supports were also fabricated as needed from odd lengths of pipe, of such strength and rigidity as were best suited for each condition. In the illustration, it will be seen that the only joints not welded were the connections to valve flanges. A total of 443 welds were made, ranging from 91 in 2-in. pipe to 7 in 14-in. pipe. Specifications as to materials, design, erection and testing as given in the 1935 Tentative Code of American Standards Association were followed.

Valve Corrosion

By W. E. Warner

WE EXPERIENCED some trouble with stainless steel valves used in conjunction with leather washers due to slight pitting and corrosion. This was finally traced to chemicals working out of the leather which had been used during tanning. With some forms of tanning this is frequent and unavoidable and the chemicals are strong enough to attack stainless steel. There is only one effective way and that is to prevent the chemicals working out. This can be done by melting a small quantity of tallow and then applying a thin film to the washers by a small paint brush. This treatment was found effective and entirely prevented the trouble.



How Would You Do It?

In his travels Our Hero unearthed a puzzler in a plant which was carrying a 5800 lb. per hr. process load with no returns. Although the plant was equipped with a double effect evaporator the process load was carried direct on the boiler through a reducing valve and the makeup supplied from the first effect evaporator working alone. The vapor from the first effect evaporator was condensed by water from the cooling pond, requiring an additional 6960 lb. of steam to evaporate sufficient makeup to compensate for the 5800 lb. process loss. Our Hero wanted to know how to stop this apparent loss because a boiler load of 12,760 lb. per hr. seemed excessive for the process requirements.

PROBLEM 10

Process Steam Supply

CONTRARY to the general opinion expressed, Problem 10 was not drawn from the Editor's imagination but represented actual plant conditions. In spite of a loss of several thousand dollars a year to the cooling pond, a loss which is quite evident on even a casual examination, it took the engineer many months of hard work to convince the management that the minor changes necessary to correct the condition should be made.

Unfortunately, this is not an isolated case. The difficulty in getting changes made is sometimes due to the fact that the management is not engineering minded, but more often the error is perpetuated because those in charge (sometimes the management, sometimes the engineer himself) feel that any change is admission of error in the first place and as long as no change is made the original layout is justified.

Practically any change made will be an improvement over the original arrangement of Problem 10, and a large number of possible solutions were offered. Most, but not all recognized as stated casually by Jesse L. Erisman of St. Louis, Mo., that "with the present hookup, the big loss is in the heat absorbed by the cooling water from the spray pond." The majority felt that the most desirable change would be to supply the process steam from the evaporator, thus effecting a heat reduction of, roughly, 35 to 45 per cent, depending on the details of the arrangement used.

Mr. Carlson was awarded first prize because of: an economical solution involving no new equipment and only minor piping changes; consideration of several possibilities; consideration of many operating factors including evaporator capacity; and provision for continuous operation should the normal heat balance be disturbed for some reason.

First Prize Award
E. H. Carlson
Fresno, Calif.

HIGH STEAM CONSUMPTION is attributed to not utilizing the existing equipment to advantage. It is assumed that superheated steam at 200 lb. ga. is essential to operate the turbines thereby necessitating operation of evaporating plant at high heat level. Reference to steam tables shows the heat of the vapor is 903.6 B.t.u. making the total heat pick-up of the first effect evaporator 6,300,000 B.t.u. First effect vapor pressure and feedwater temperature are not given but heat absorption will produce for example 5800 lb. of vapor at 0 lb. ga. with 98 deg. F. feedwater. The temperature fall, 500 minus 212 or 288 deg. F. indicates lack of heating surface and the possibility of heavy scale formation on the evaporator tubes.

The output of an evaporator depends primarily on the amount of heating surface, the mean temperature differential, and the co-efficient of heat transfer. An analysis of the present performance of the first effect reveals that the combined heating surfaces of both evaporators is sufficient to produce process requirements at 50 lb. ga., 298 deg. F. Since saturated steam would be thus produced, 6237 lb. per hr. would have to be supplied to furnish 7,350,000 B.t.u. or process.

Figure 1 outlining the proposed arrangement shows parallel operation of both evaporators and the use of the condenser to preheat evaporator feedwater and provision to makeup condensate losses for boiler feed purposes. The latter feature is essential because in practical operation it is impossible to obtain 100 per cent recovery of condensate. The boiler output of 8,736,000 B.t.u. is 1,386,000 B.t.u. in excess of process consumption. The excess heat is more than ample to heat the evaporator feedwater to an estimated 210 deg. F. and unless the boiler feed pump layout is designed to handle hot water above 212 deg. F. (flash point at 0 lb. ga.), a slight amount of excess heat will have to be disposed of in the pond.

Our Hero's friend has been using 16,141,000 B.t.u. from the boiler and since the proposed method will save 7,405,000 B.t.u., the approximate fuel saving figures 46 per cent. Also, the expense of pumping a large amount of pond water to and from condenser is elimiated. No additional equipment is needed although cost of minor piping alterations is involved.

The writer considered two other schemes for improving fuel consump-

PROBLEM No. 11—ENGINEERS WANTED

Faced with the problem of getting his new 25,000 kw. steam turbine plant in operation shortly, Our Hero had given little thought to the securing of a competent operating engineering staff until he read this portion of a letter from Theodore L. Sharp, Chief Examiner, Civil Service Commission, City of Glendale, Calif. "We did not receive enough applications on our first posting of the examinations for Chief Engineer (Power Plant) and Watch Engineer (Power Plant). We are therefore posting the bulletins again." What bothers Our Hero is to know why engineers were not sufficiently interested in these opportunities to make applications for these examinations. (Incidentally, if you are interested, the period for filing ends on July 18, '40.) Size of plant 20,000 kw. Written examination to be held at various places in the United States but oral interview to be held in California. Salary range of Chief Engineer between $260 and $310 per month, of Watch Engineer between $190 to $240 per month. Age limits 50 and 40 yr., respectively. Residence requirements waived. The duties, education, experience and special qualifications are all in line with what would be expected for positions of this type. What Our Hero wants to know is what is wrong with the Glendale proposition that it has not attracted applications. He does not want his own offer to engineers to be turned down to the point where he will be delayed in starting operation under competent supervision. (For the most helpful 1000-word contribution on this problem, a prize of $15.00 will be paid, the second prize will be $5.00 and the third $2.00. Contest entries must be received by July 25.)

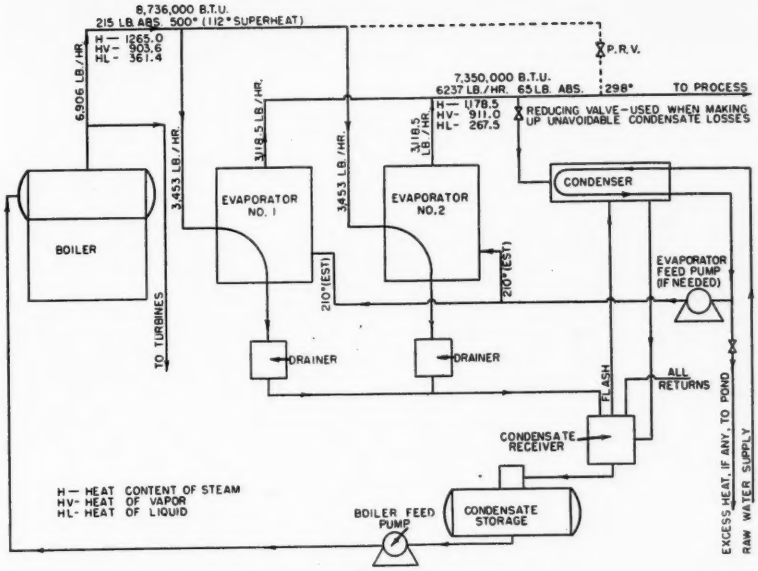


Fig. 1

tion which were abandoned because of higher heat requirement and other obvious reasons. These schemes are briefly described below:

1. Series operation of both evaporators (double effect) disposing of vapor from the second effect to process. Condenser is used for heating evaporator feedwater. Surplus condensate produced by double effect operation is passed to raw feedwater and revaporized. This requires a boiler output of 9,550,000 B.t.u. and installation of additional auxiliary equipment. Due to lower mean temperature differential in evaporators, it appears that the heating surfaces are inadequate to produce sufficient process steam at 50 lb. ga.

2. Supply process heat direct from boiler. Operate both evaporators in series (double effect) using the condenser to handle the vapor from the second effect. This requires 11,930,000 B.t.u. from the boiler and necessitates the operation of the condenser cooling water pump.

Second Prize Award
R. Atlas
Staten Island, N. Y.

IN COLD FIGURES, the cooling water is carrying to the pond $6210 every year. This is based on a steam cost of 40 ct. per thousand pounds of steam, a 9 hr. day, 6 day week and a 50 wk. year. If the plant is working more than that, our Hero can feel worse, for they are losing more than $6210 a year. The general outline of what to do about it is simple. Change over to a closed boiler water system, evaporating water directly for process. There are two methods of working it out. First is the scheme shown by Fig. 2. The amount of process steam is increased slightly since it is now saturated instead of being superheated to 470 deg. F. as before. The loss in flashing to the receiver is less than before, also, because of the lower condensate pressure. If the present evaporator can be utilized, then the investment is small, a pump, valves and a change in piping. The cost will be around $900, which is small compared to the saving. With a new evaporator, the cost may be between $6000 and $7000, which will be amortized in 14 mo.

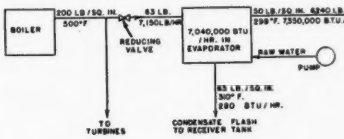


Fig. 2

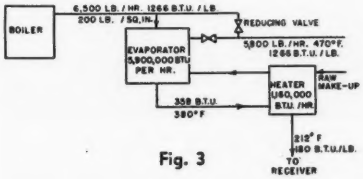


Fig. 3

Based on either of these schemes, a flexible and modern heat balance can be designed. For example, the evaporator capacity should be increased to make up for steam lost in the boiler and turbine, and that steam at 50 lb. pressure used for feedwater heating. Considering the saving of coal, spray pond operation and additional costs of an antiquated arrangement, modernization will quickly pay for itself.

Second Prize Duplicate Award
By Alf Hansen
Denver, Colo.

WE AGREE that there is something radically wrong when 12,760 lb. of steam per hr. has to be generated to supply a 5800 lb. process load. In the first place, it is wrong to run the steam through the reducing valve to the evaporator. If live steam was used in the evaporator, vapor may be produced at 50 lb. ga. pressure for process. We, therefore, suggest that the evaporator be connected in parallel with the reducing valve. The reducing valve will act merely as a pressure regulator, and a negligible amount of steam will go through the reducing valve during normal operation. The suggested arrangement is shown by Fig. 4. We assume that the cold water to be evaporated is 60 deg. F.; that no under cooling of drains takes place in the evaporator; that the blowdown is 3 per cent.

Steam to evaporator: S_2 lb. per hr.
Vapor from evaporator: V_1 lb. per hr.
Feed to evaporator: W_1 lb. per hr.
Then: $0.97\ W_1 = V_1$ and
$(1267.3 - 361.9)\ S_2 =$
$(1179.1 - 28)\ 0.97\ W_1 +$
$(267.5 - 28)\ 0.03\ W_1$
By substituting V_1 for W_1 and solving the equation, we get:
$S_2 = 1.278\ V_1$

Assuming that no steam goes through the reducing valve, no evaporation for makeup is required; therefore,

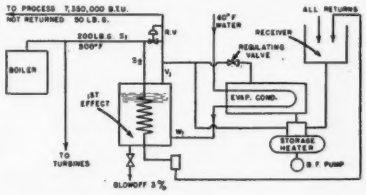


Fig. 4

$V_1 = 7{,}350{,}000/1179.1$
$= 6240$ lb. per hr.
or the live steam supplied is
$1.278 \times 6240 = 7970$ lb. per hr.

The saving will be 12,760 minus 7970 or 4790 lb. per hr., or 37.6 per cent. If the present evaporator is good for 200 lb. ga. pressure and 500 deg. F. temperature steam, the cost of the change is negligible. We do not have sufficient data available to work out the actual saving in dollars.

We have also considered the installation of a 200-kw. non-condensing turbine in place of (or in parallel with) the reducing valve. Such a turbine would operate in parallel with the present turbo generators (which I assume are 3 ph., 60 cy.) and tied in on the line electrically so that the new 200 kw. turbine can be governed by a back pressure governor.

All the steam used for process and for the evaporator can then be passed through this turbine instead of through the reducing valve and generate electrical energy in accordance with the

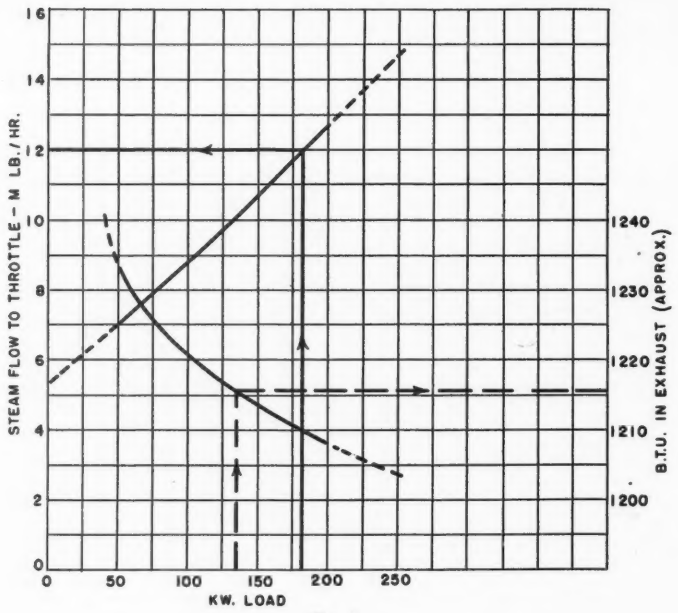


Fig. 5

load curve, Fig. 5. I shall not go into detail on the calculations in connection with this installation because our calculations show that the installation will cost approximately $16,000.00. The steam saving based on a steam rate on the present turbo generators of 14.5 lb. per kw-hr. is only 2500 lb. per hr.

If the present evaporators are not good for live steam, new evaporators can be purchased for much less than the cost of a 200-kw. turbine and the saving is greater.

Third Prize Award
Henry E. Zeffren
Laclede Power & Light Co.
St. Louis, Mo.

THE EASIEST as well as the most economical method of generating the process steam requirements would be to operate the evaporator at 50 lb. pressure, and send the evaporated steam directly to the process, instead of sending high pressure steam through a reducing valve. (See Fig. 6.) If the capacity of the first effect was not sufficient at this pressure, the second effect could be operated in parallel with it. Drains from the evaporators could be passed through heat exchangers to heat the incoming feedwater, as could the evaporator blowoff.

If sufficient steam for feedwater heating to the boiler feed is not available, flash tanks instead of heat exchangers can be used on the evaporator drains and blowoff water, and the flashed steam used in the storage heater. This layout (Fig. 6) will reduce the high pressure steam load at least 5800 lb. per hr. and save approximately 45.5 per cent of the fuel bill chargeable to process steam.

The cost of the change will be very small, entailing only the purchase of two heat exchangers, and if the management balks at this, flash tanks can be used instead at only a small sacrifice in economy.

In the event that the evaporators will not withstand 50 lb. pressure, or water is so bad that operation at 50 lb. is impossible, the evaporators can be operated double effect (See Fig. 7) with steam from the first effect passing to second, drains from both effects passing through heat exchangers to heat water entering each evaporator, and steam from second effect passing to storage heater to heat boiler feedwater. Cooled drains from both evaporators pass to receiver and thence to storage heater.

Cost for this system will be the same as Fig. 1, but saving would be much less since the 5800 lb. per hr. of high pressure steam for process would still be required, as well as an additional 3480 lb. of steam for evaporation, making a net saving of 3480 lb. of steam per hr. or 27.3 per cent of the fuel bill chargeable to process steam.

GENERAL COMMENT

A large number questioned the advisability of using 50 lb. saturated steam and several made provisions for supplying superheated steam ranging from a few degrees up to 100 deg. F. superheat. The easiest method would be to supply some of the process steam through the reducing valve shown by Fig. 1 and the balance from the evaporator.

Another method was suggested by Bernard T. Hensgen, Plant Engineer, Swift & Co., National Stock Yards, Ill. This involves a thoroughfare steam-to-steam reheater as shown by Fig. 8. He says, "The cost of this installation should be around $1000." With 50 deg. superheat and 5 per cent heat loss he figures a steam requirement to the evaporator of 6700 lb. per hr. This is a saving of some 6060 lb. or 7,560,000 B.t.u. per hr. which, "at 40 ct. per million B.t.u. equals $3.02 per hr. which on a 2000 hr. basis gives an annual saving of $6040."

Harold D. Brown of Chicago also suggests the use of evaporator vapor for process "if the present evaporators are strong enough" and goes on to add "If the plant is large the process steam might be furnished from an economizer used as a waste heat boiler. Also if superheated steam is preferred for the process it might pay to install superheaters in the last pass of the boiler."

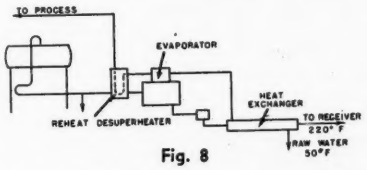


Fig. 8

In case one evaporator effect is not serviceable, Albert M. Ogent recommends using one effect to supply distilled feedwater to what he calls a reducing valve evaporator supplied with live steam. In effect this amounts to an open type desuperheater and he estimates the cost as $450 and the fuel savings about 80 lb. per hr. If superheated process steam is required he also suggests the steam be "passed through a superheater located in furnace setting or near smoke breeching or a separate steam heated superheater of low pressure vapor to desired temperature of 470 deg. F. and a vapor pressure of 50 lb. per sq. in. ga."

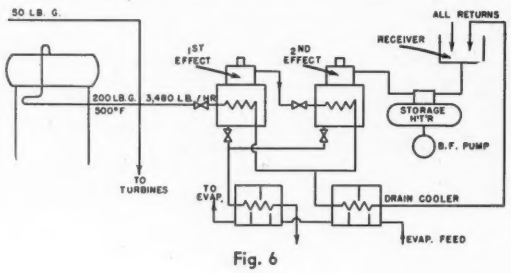


Fig. 6

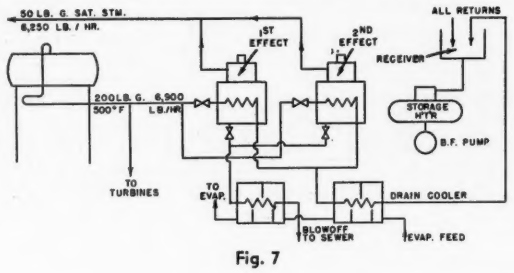


Fig. 7

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Questions And Answers

Don't Hurry Water

In the February issue, p. 66, there is an article on "Don't Hurry Water" by Geo. P. Pearce. Will you please show me how the calculations were made. I would particularly like to know the formula or table by which he secures the 2 ft. per sec. velocity and the 2.12 lb. pressure drop per 1000 ft. of pipe.

GEO. H. WEINDEL.

Cincinnati, Ohio.

* * *

Original computations were based upon the arrangement of the Hazen-Williams Formula as shown below. Take the velocity as 2 ft. per sec., the constant "c" for steel pipe at 140 and the hydraulic radius for standard steel pipe, 4 in. size with the internal diameter reduced to 3.62 in. to allow for the interior protective coating and solve the equation. This gives the pressure drop per 1000 ft. of pipe at 2 lb. per sq. in., which answers Mr. Weindel's question. I also invite his attention to the fact that the above mentioned formula is the one used by the National Tube Co. of Pittsburgh, Pa.

The Hazen-Williams Formula is

$$h_f = 1000 \sqrt[0.54]{\frac{v}{1.318 \times c \times r^{0.63}}}$$

h_f = loss of head in ft. per 1000 ft. of pipe.
c = coefficient for loss of head in pipe.
v = velocity in ft. per sec.
r = hydraulic radius in ft.

For v = 2 ft. per sec.; c = 140 for steel pipe; $r^{0.63} = 0.19625$ for 4 in. standard pipe reduced to 3.62 in. inside dia. to allow for protective lining; then—

$$h_f = 1000 \sqrt[0.54]{\frac{2}{1.318 \times 140 \times .19625}}$$

$= 4.6253$
$= 2$ lb. per sq. in. loss of head per 1000 ft. of pipe.

GEO. P. PEARCE.

Las Amimas, Colo.

Editor's Note: It should be noted that calculation of pressure loss in pipe is somewhat problematical as to accuracy due to the uncertain condition of the interior pipe surface, bends, etc. This is pointed out in the article Pipe Friction on page 544 of the August issue, which also mentions the pipe friction tables published by the Hydraulic Society. These tables, based on 15 yr. old cast iron pipe, give for a 4 in. pipe and a velocity of 2 ft. per sec., a friction loss approximately four times that calculated above for the special cement lines pipe assumed by Mr. Pearce. This difference in type of pipe and method of calculation is one of the causes for the difference of opinion expressed below by M. Hubbard. The other point of difference seems to be the "practical man" vs. "the technical man", always a cause of argument—and it seems to us always equally pointless.

* * *

SNAPPY JOE shows a lack of judgment and selection in the solving of the problem. First, he calculated (or takes from tables) the friction loss for 5400 ft. of straight new clean smooth iron pipe. He does not give consideration to the other friction losses that must be present in any system of piping and these friction losses can be of some magnitude. A check of Joe's friction loss for straight pipe only indicates a value that would be had from the Darcy formula when the minimum friction factor for 4 in. pipe is used. Results from the exponential formula approximate the Darcy value.

Using a friction loss equal to the minimum friction loss for new, clean pipe (5400 ft. of straight pipe only) our Joey proceeds to select a 5 hp. pump. Are centrifugal pumps ordered on such a specification? Does he mean that he wanted a pump to furnish 77 g.p.m. against a total head of 50 lb. per sq. in. and fitted with a 5 hp. motor? Has Joe ever heard of the suggestion by Hoskins—"The degree of roughness or smoothness must be a matter of judgment of the engineer, but, except in the rare case when pipe lines are laid for temporary use only, the design must be governed by the probable future conditions rather than by the character of the pipe when new?" How about such things as character of the pipe surface changing with age—accumulation from water on surface of pipe —efficiency of pump "falling off" with age?

Second, since belligerant Joe is bent on using the minimum friction loss, why did he not discover that for Mr. F.'s plan of operating that the horsepower necessary at the pump runner coupling was considerably less than 40 hp No doubt Mr. F. had anticipated the future.

Third, outspoken Joseph did not arrive at his results during the 3 hr. that elapsed between the time that the manager told him "to get busy" and the time he returned the report. Joseph, the sly, had worked on the problem during the alleged "3 mo. of mysterious action." Joseph could have given the manager his report at the first interview, but he did not do so. He waited for 3 hr. in order to show the manager that he could do in 3 hr. what it took the alleged brother-in-law of the manager 3 mo. to accomplish.

Fourth, if it was a new pipe line, did our hero Josephus make any computation for various sizes of pipes and rates of flow in order to determine the minimum yearly cost for pumping the water?

Fifth, the story of Joe as told in the article is a rehash of the perennial article in which our hero (the plant person) "always gets his man." The man in these tales is the outside technical man or consulting engineer—these two are always failures. In your last two paragraphs you inadvertantly "showed up" Joe as the tale ends with the manager being shown as a gentleman, while Joe is still a boor and a lout.

CHARLES HUBBARD

San Francisco, Cal.

* * *

MR. HUBBARD does not like the quick action on the part of Joe, however, his

COAL PURCHASING CONTRACTS

FUEL PURCHASES are probably the most important single factor in power plant operation and W. C. W. would like to know more about purchasing and contract practice in different parts of the country. Is it practical to purchase coal on a specification basis or must the integrity of the coal company be depended upon to maintain the quality? If a penalty clause for poor quality is included, should it cover only the heating content or moisture and ash as well? Should a bonus be given for coal better than the contract specification? Who pays for the sampling and analysis? How are the various proposals evaluated? W. C. W. uses the following formula for comparison purposes

$$C = (2000\ HD) \div (P + [0.5A])$$

Where C is a comparative constant, really the B.t.u. purchased for one cent; H is the heating value per pound on a dry basis; D is moisture free coal expressed as a fraction of the coal as fired, i.e., 1.00 minus the moisture; P is the price per ton expressed in cents; and A is the ash expressed as a percentage. He would like to know if this formula is widely used and if it places sufficient penalty on ash content.

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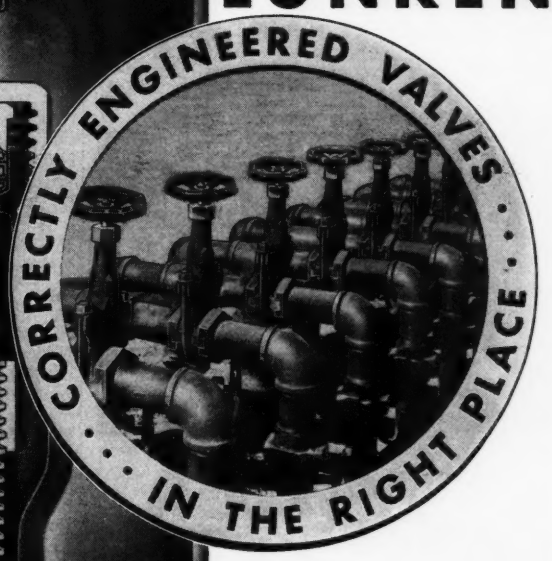

FIG. 1640 I. B. B. M.
150 lb. S.P.
225 lb. W.O.G.

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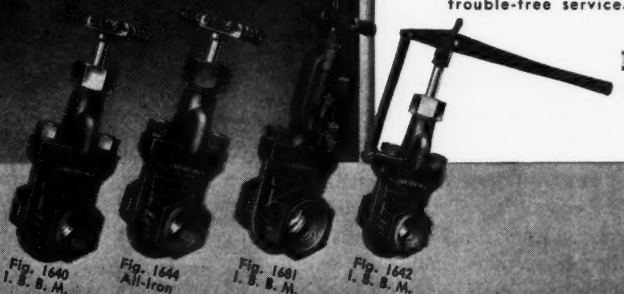

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Here's a Profit Tip--

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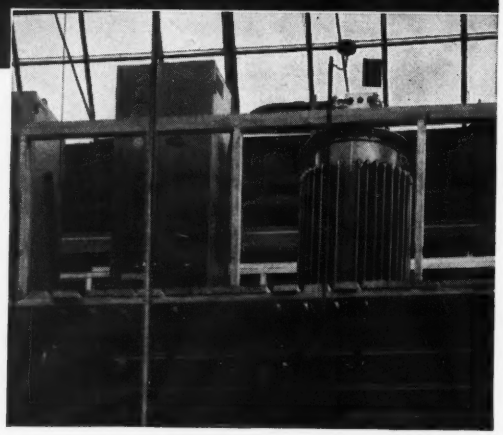

-- for Savings Like These

1. "We saved $500 on installed cost by using a Pyranol transformer to supply a lighting load," says R. H. Lewis, electrical superintendent of the Motor Wheel Corporation, Lansing, Michigan. This saving was possible because a fire-proof enclosing vault—which would have been required with an oil-filled transformer—was unnecessary, and because floor space was saved by mounting the Pyranol transformer on an overhead platform. By placing the transformer right at the load center, the cost of running a heavy three-wire secondary for 500 feet was also avoided.

2. The Byron Jackson Company, Los Angeles, installed a bank of three 200-kva Pyranol transformers in space that could not be used for production. The non-inflammable feature of Pyranol enabled this company to save the cost of building in the production area of the plant, an underground vault, which would have been required with oil-filled transformers.

3. Putting a Pyranol transformer at the load center cut feeder costs 50 per cent on a lighting circuit in the new recreation building of an Alabama cotton mill.

Find out for yourself how you can save on power- or lighting-circuit installations by installing G-E Pyranol transformers indoors at load centers. After installation you will get daily dividends in the form of reduced copper losses, better voltage regulation. Ask your G-E representative for complete information, or write today for Bulletin GEA-2637. Address General Electric, Schenectady, N.Y.

GENERAL ELECTRIC

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criticism is entitled to consideration. He speaks first of the friction loss and later adds that there are other "friction losses." Joe's 4 in. water line ran straight from the gate valve at the centrifugal pump discharge to the 30 in. riser leading to the bottom of the water storage tank and I cannot imagine any other friction loss of any important magnitude other than the pipe friction. All water lines do not clog up with scale and properly treated pipe does not form appreciable rust tubercles. A special cement lining known as Duroline developed by the National Tube Co. is, according to their tests, practically free from tuberculation.

Regarding the Darcy experiments and formula—Joe did not use them. Darcy was a French engineer who did good work but since his conclusions were arrived at 90 yr. ago there has been considerable progress since. The Hazen-Williams formula is generally used now for flow in pipes. When Joe spoke about a 5 hp. pump he was referring to power consumption and a lot of technical details would have been out of place. I do not see any difficulty in Joe's solving a simple problem in water flow through pipes in 3 hr., that was ample time. Regarding the fourth criticism, it seems that the reduction in cost by Joe's method was plenty good enough and not much more could be gained by further calculations which may indicate some motor size not in standard production.

GEORGE P. PEARCE

Las Animas, Colo.

Ammonia Receiver Capacity

IN OUR PLANT we now have 100 t. of ice making and 75 t. of cold storage capacity. The plan is to cut ice making to 50 t. and increase the cold storage to 125 t. How do you make the receiver of the proper size to hold that charge?

THERE ARE several ways of answering this question. If the 100 t. of ice making refers to the actual production of 100 t. of ice a day, it would take around 160 t. of refrigerating capacity for this load, in addition to the 75 t. of cold storage capacity. The total of these, 235 t., would be 30 t. greater than the capacity required for making 50 actual tons of ice and do 125 t. of cold storage work.

Figuring that the 100 t. means 100 t. of refrigerating capacity devoted to ice making work, the load after changing to 50 t. of ice making would, of course, be the same as originally, being fixed at 175 t.

In the first case the receiver would be large enough, as it obviously is in the second case. If it was desired to have the receiver large enough to hold the entire charge of ammonia, then its volume should be calculated from the amount of ammonia in the system, allowing a reasonable gas space in the top of the receiver to prevent its exploding if the temperature should rise when the valves are closed.

However, it is only once in a life time that an engineer would want to put his entire charge of ammonia in the receiver, so that modern practice rarely if ever demands the use of a receiver that large. In fact, now that the coils or coolers are generally operated flooded, under the control of float valves or electric valves, most of the charge of liquid is kept on the low side. In cold storage work there are generally enough rooms to put some of the liquid in the coils of one of them when pumping out the coils in the other.

Our recommendation would therefore be that if the receiver has been large enough in the past it would hardly need to be increased at all. As long as it provides a steady liquid seal between the condensers and the expansion valves, and has a sufficiently large outlet to carry the liquid away without increasing the velocity in the line above say 200 ft. per minute, it should be satisfactory.

If W.S. wishes to supply details of the piping in the ice tank and storage rooms, together with a description of the receiver and its connections, and would include a description of the manner in which the plant is handled, it might be possible to give him some additional help if it seems required.

Frick Co. TERRY MITCHELL
Waynesboro, Pa.

Synchronizing

WHEN SYNCHRONIZING one alternator with another, I would like to know what is done at the switchboard to bring the two machines in step. I have studied a lot about synchronizing alternators but have never had the privilege to be at the switchboard at the time. I would like to know what the person does or what action he takes at the switchboard to bring the two machines in step. C. W. P.

THE PROCESS of synchronizing one alternator with another is quite simple. In general the operations involved are as follows:

1. Start the turbine or other prime mover driving the incoming generator and bring the machine up to approximately normal speed by manipulating the throttle or governor control.

2. Close the field switch.

3. By adjusting the field rheostat, bring this machine up to voltage, that is a voltage equal to that of the bus to which the machine is to be connected.

4. Close the switch on the cynchronizing circuit and watch the synchroscope. The synchroscope indicates at any instant the difference in phase between the voltage of the incoming machine and the voltage of the line to which the machine is to be connected. When the two frequencies are different, as they are quite likely to be when the switch is first closed, the pointer of the frequency changer will be constantly changing. The pointer will rotate either in a fast or slow direction, depending upon whether the incoming machine is running slower or faster than the machine already connected to the line.

So, if the synchroscope indicates that the machine is running too fast, the turbine governor should be adjusted to slow the machine down; if the synchroscope indicates too slow, the speed of the machine should be increased. By this back and forth adjustment of the turbine or engine control mechanism the frequency of the incoming machine is gradually brought into synchronism with the frequency of the line and at the instant of synchronism the synchroscope pointer will come to rest at the zero field position. At this instant the main circuit breaker is closed and the machine placed on the line.

In actual practice it is not necessary that the synchroscope pointer be absolutely at rest. An experienced operator watching the synchroscope can anticipate the instant at which the pointer crosses the zero line and he can usually synchronize the machine even if the pointer is moving across the face slowly.

Use of Chlorine

WILL YOU give me some information and data on the use of chlorine as an aid or adjunct to alum for coagulation in conjunction with the preparation of water for filtering.

EARL L. EVERLINE.
Paulsboro, N. J.

REGARDING chlorine as an aid in conjunction with alum in the coagulation of water, there is considerable reference in literature to the advantages obtained. The most important is sterilization, not only in the finished water, but as prechlorination ahead of all other treatment in the plant. Pre-treatment will kill most organisms commonly found in raw waters and consequently places less load on the filters. This, in turn, increases filter runs, thus effecting savings.

In certain types of water oxidation of organic coloring is effected, thus enabling lower doses of alum to accomplish the same color removal. Some operators have found that chlorine ahead of the alum treatment caused a condition whereby a larger and faster settling floc was formed, thus enabling shorter settling times. At Danbury, Conn., chlorine doses of 2 p.p.m. reduced alum requirements about fifty per cent. In another case the Brantford, Ont., plant found that with prechlorination alum doses were decreased from 2 to 0.5 grams per gal.

Due to the wide source of raw water no definite formula can be given to calculate savings by chlorination ahead of alum treatment, but from experience in most plants it is apparent that sufficient savings are offered to warrant prechlorination.

A. E. GRIFFIN,
Tech. Service Dept.
Wallace & Tiernan Co., Inc.,
Newark, N. J.

Letters and Comments

Mr. Scheffer Is Perturbed

IT IS an economic crime that the establishment of correct public relations of the public utilities lags so far behind their technological development. It would seem that for every step the technical staff advances, the public good will loses two.

With conditions as they are at present, even a by-stander would think that the utility companies would do everything in their power to obtain public good will in such amount that it would insure protection of their property rights. Whether they are too stubborn, too uninterested, or just too lazy to protect their own is problematical. Oh, of course, something has been done. But how very little! The feeble efforts of the local power company to inform their customers of the value of electricity in their daily lives through the antics and limericks of one "Reddy Kilowatt" is a magnificent example of futility. Because, no matter how economical is the power of "Reddy Kilowatt," it is of no avail unless the little fellow is on the job. In other words, service is terrible.

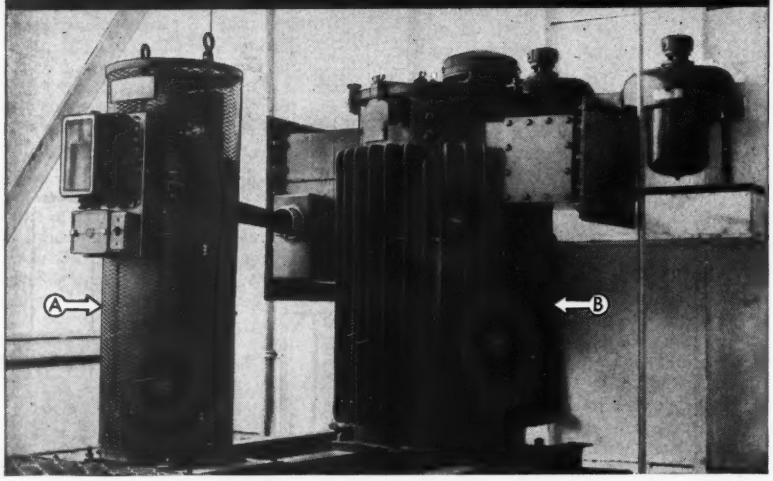
Another thing. Just as much attention should be paid to the selection of office help, especially that part of the help that comes in contact with the public, as there is to the employment of the engineering force. When a reader of domestic meters enters a residence looking and, alas, acting as if he had come from a pig sty, why, that surely creates an unfavorable attitude toward the company.

And a little common courtesy in the handling of legitimate, or otherwise, complaints would be indicated. A customer with seventeen years' experience in the generation and distribution of electric power does not relish being told that "he could not possibly know anything about it." Especially by a female pencil pusher. And a housewife, not knowing the whys and wherefores, should not be presented with a monthly bill, when she knows full well that her meter has not been read for months. The above occasions are actual, not fictitious.

In the rural districts, some means of handling complaints should be established, by special office if necessary. The way things stand at present, a customer would think, and rightly, that he might just as well be under the thumb of a bureaucrat as the domineering heel of the local power company's representative.

While advertising is an undoubted help in maintaining public good will, nevertheless an efficient, courteous office force will go far toward holding the cordial relations between company and consumer. WILLIAM SCHEFFER.
Wingdale, N. Y.

Now A G-E "REGULATOR" TO GIVE YOU BETTER LIGHTING —BETTER MOTOR PERFORMANCE



This G-E air-cooled regulator (A) in a modern factory provides precise voltage control for the lamps supplied by Pyranol transformer (B)

You know that voltage delivered at the correct level at your service entrance may fluctuate widely on your plant circuits because of varying power loads and lighting loads. You also know the advantages—in higher efficiency and increased production—of maintaining correct voltage on these circuits.

Now you can do it—economically—with the new G-E air-cooled Type AIRS regulators. They give a smooth, precise automatic voltage regulation that means better lighting, better motor performance, and better service from other electric equipment.

They are easily installed. Because they are air cooled, they require no expensive fireproof vaults. They take little space, and can be placed in out-of-the-way locations, even on beams up near the ceiling. Available in ratings from 1.2 to 12 kva, for 120-, 240-, 480-, and 600-volt circuits, and 10 per cent raise and 10 per cent lower regulation.

Find out for yourself how little these regulators cost. Ask your G-E representative for details, or write for Bulletin GEA-3057. Address General Electric, Schenectady, N. Y.

And for Testing—the Voltage You Want When You Want It

In many laboratory tests, precise voltage control is a major factor in accuracy of results. The new hand- and motor-operated Type AIRS regulators are available for a range of 100 per cent raise and 100 per cent lower, and give the exact voltage you require—at a turn of a crank, or of a switch. Complete description in GEA-3057.

GENERAL ELECTRIC

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The Boiler Inspector

WHEN I got back from Florida last week, I found in my mail many letters asking about the questions (See "So You Want to be a Boiler Inspector", p. 74, February issue) and I have already disposed of nearly all the copies I have. Also I have made arrangements to coach several applicants and have heard from several casualty companies wanting to get in touch with applicants who seem to be qualified for a job. There seems, therefore, to be an opening in that direction for some enterprising fellows.

Logansport, Ind. C. C. CUSTER.

False Modernization

A GREAT deal has been said about rebuilding the old power plant to increase its efficiency and lower its operating costs. In many cases much money and time have been wasted on plants, which after a complete analysis would show that it would be more economical to scrap the old equipment and install new. At times much money is spent on making a few superficial changes which increase the efficiency somewhat but after the cost of the new equipment and its operating costs are taken into consideration the small saving does not justify the expense of modernization.

Some time ago an industrial company due to the ever increasing overload on its old hand fired boilers sought means of increasing the steam output without installing additional steam generating equipment. The plant consists of five h.r.t. boilers which should have been scrapped as they were then about 18 yr. old but, due to the high overload at which they were operated, and the poor feedwater used, the boilers had an equivalent age of 30 yr.

Stoker company engineers made surveys, and company engineers did considerable figuring with the result that the cheapest stoker was selected, one which was neither the proper type nor the proper capacity. The price was the only feature investigated. Then came the expense of raising the boilers, changing the lower halves of the boiler fronts, and digging a large pit in front of the boilers. Additional money was spent on installing superheaters, a useless expense since the steam driven air compressors operate on throttle in order to keep a certain amount of back pressure, variation in the air load being taken care of by electric driven variable capacity compressors.

The stoker company sent down a man to show how easy and simple cleaning the fires would be. When he attempted to clean the fire he found it an impossibility as the clinkers had fused to the brick work in a rocklike mass. The boiler had to be taken off of the line and the clinkers chipped out by hand. The furnace had to be rebricked with a special brick. After all this expense, operating the plant is a very disagreeable job as the coal has to be placed in the hoppers by

hand. The fires have to be raked over by hand, and when the load is heavy this has to be done rather often, thus destroying the very advantageous features of stokers.

Recently the boilers have been inspected and will be condemned in about 3 yr. I can't see how the expense of patching up such a plant is justified. The money could have been used to install new steam generators, more expensive in first cost, but cheaper in the long run.

TORQUIN DE ROSA

South Vineland

We Get Around

HAVE BEEN very much pleased with the kind, cordial and helpful response to my appeal for help in regard to magnetic brake troubles. I never expected so many replies and from so many parts of the country. PPE certainly does get around. . . . I wish to express appreciation for your personal interest in my problem. It makes me realize that, as a subscriber to the paper, all I need do when in trouble is to let it be known and help and advice will be immediately forthcoming. ARTHUR H. PARKER.

Petersboro, N. H.

* * *

IT CERTAINLY was a generous response from your readers in answer to our questions and we find several of them of real value. Each one was mailed a short letter of acknowledgment and appreciation, thanks to your thoughtful suggestion. RICHARD E. MURPHY.

Mansfield, O.

* * *

WISH to express my appreciation of your assistance in determining the circulation of water in an H.r.t. boiler. After reading the various opinions expressed and apparent proof of many conflicting theories, I have come to the conclusion that you had the right idea in your first letter when you said that variable conditions might lead to different forms of circulation. I wish also to express through you my thanks to the engineers who so courteously offered their assistance.

FARRAND H. VAN DYKE.

Worcester, Mass.

* * *

WAS VERY MUCH PLEASED to see in the two issues the articles by Egbert Douglas which I feel is the best I have seen for some time and believe the facts set forth has saved the power plant of our . . . Hotel here with all the jobs of the crew. A. A. F.

This Would Be Tough on Politicians

SINCE POWER PLANT ENGINEERING is the "Webster Dictionary" of "Generation, Transmission and Utilization of Steam, Electric, Diesel and Hydraulic Power" it is hoped by this "Chaser of Hydrogen and Carbon Atoms" that you will not only continue to encourage Practical Engineers and Electricians to exchange worth while ideas through the medium of your magazine, but eventually take the leadership in banding together the practical engineers interested in the conservation of fuels and power.

We have several so called national societies which sponsor research in fuels and power, their membership is made up largely of technical graduates and their publications are as far over the practical engineer's head as a cat is from heaven. Of course the scientist is making his contribution to mankind by his research, without them we would stand still, but our conservation of fuel and power program cannot be carried out in the laboratory by scientists.

The fellows feeding the furnace and the ones directing its meal of fuels are the real "crusaders" of fuel and power conservation. Sir, the point being advocated is that the practical engineers of this country, engaged in power plant operation, need a powerful leader like the POWER PLANT ENGINEERING to pave the way for a national organization for practical engineers, whether he had a grade school or college education. Instead of setting up a complicated group of objectives the sole objective of the organization would be the advancement of fuel and power conservation by exchange of practical ideas by practical engineers.

Place a copy of P. P. E. in the hands of every power plant supervisor in the United States each month, and the government will no longer have to spend the taxpayers' money on an educational program of natural fuels conservation.

C. D. E.

We Are Now Gentlemen—Thank You

EDITORS of P. E. & E. certainly do have a vivid sense of humor. The "Ole CO_2 Inhaler" down Augusta way knew it was a mistake when his first attempt, "What—No CO_2 Bonus?" got by the censors and was published, but to have the second ("—it's up to the management") even considered is almost too much of a shock to an old excess air soaked heart. Gentlemen, if my old English prof ever finds out about this, he'll lose his other hair. He flunked me once. . . . The "Ole Smoke Engineer" has certainly enjoyed his correspondence with the editors of P. E. & E.

J. C. DE FOE

Augusta, Kan.

The West is Still Woolly

JOHN E. HUBEL offers the reproduction of this reward notice as evidence that "shooting out the lights" is a pastime of the new, as well as the old west, law or no law. During the Third World Power Conference, a few years ago, he accompanied a delegation of British engineers on an inspection trip to Port Washington Station. On alighting from the train they met a self-appointed reception committee, the cast of a Wild West Show, which with an eye to publicity, had dressed in show costumes typical of the old west, cow punchers, frontiersmen, Indians, etc.

Properly impressed, the Britishers' fears that the frontier still encroached on this supposedly civilized section of the country were soon allayed on that occasion. Had any of them have taken

REWARD

OF

$25.00

to anyone who offers information leading to the arrest and conviction of anyone shooting out street lighting bulbs or molesting the property of the city of Oconomowoc electric utility.

JOHN W. BOLSON,
Superintendent.

time off from the war to read the April 4 issue of the Oconomowoc (Wis.) newspaper, however, they might well have been excused for feeling that the earlier reception committee was closer to the truth than the natives had cared to admit. Anyway, we hope Mr. Bolson and the local "marshal" have the situation well in hand by this time and do not feel it necessary to call on Hollywood for the services of Bill Boyd and Hopalong Cassidy's trusty six-shooters.

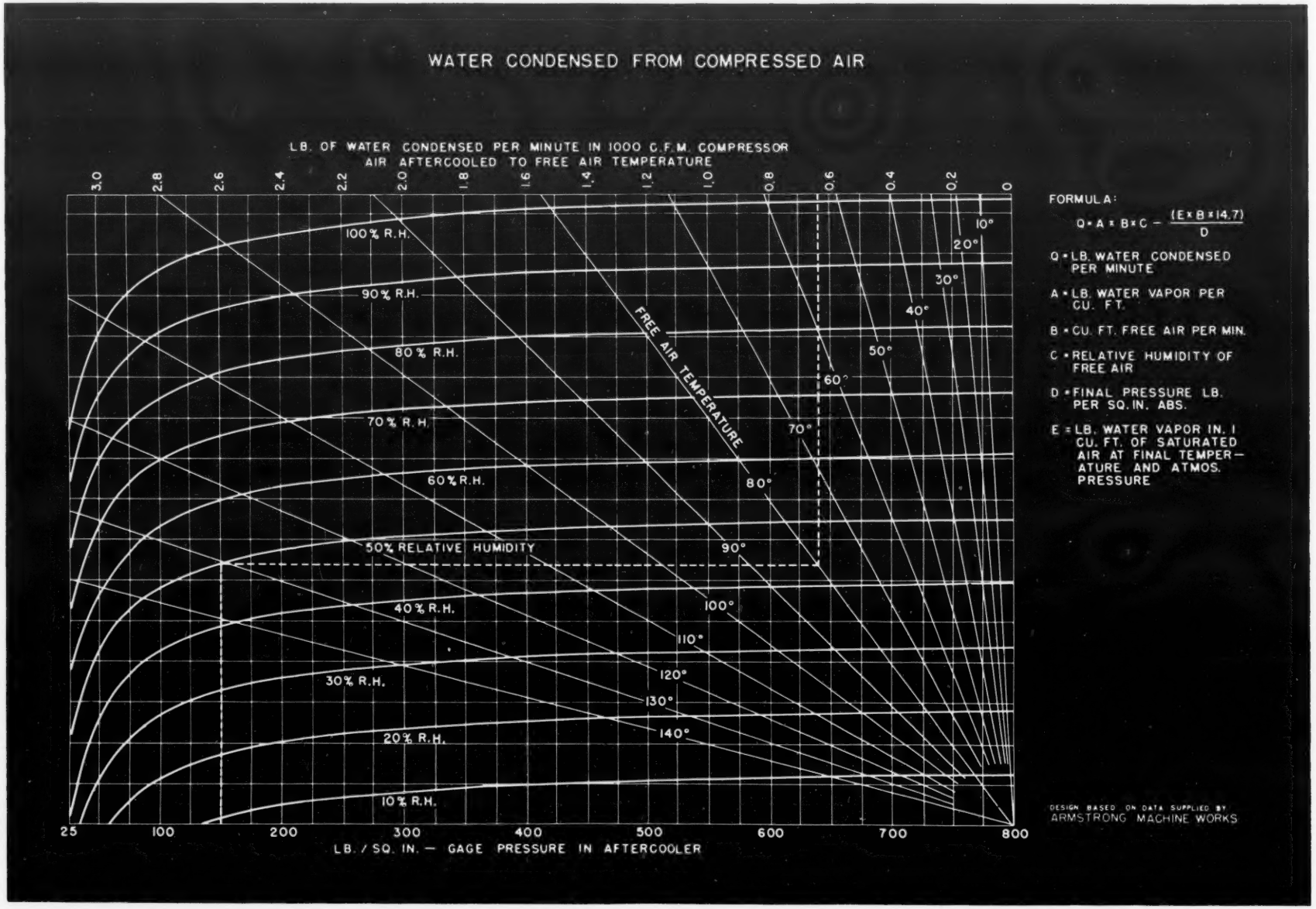
Turbine Inspection

IN CONNECTION with a questionnaire on routine turbine inspection, the following summary in given in E.E.I. Report No. F-14. Twenty-one companies submitted reports; four of these arranged for inspection every three years, seven for inspection every two years, and five for yearly inspection.

One company schedules inspection after 10,000 operating hours for condensing units of from 20,000 to 60,000 kw. capacity, and after 15,000 operating hours for topping units. Another company inspects turbines after 14,000 operating hours, one after 6000 operating hours and one after 5000 operating hours. Still another company inspects after 12,000 operating hours for base load units and 8000 operating hours for peak load units.

At Grand Coulee

This fellow works as well as he chews tobacco. He is builder No. 2555 on Grand Coulee Dam across the Columbia River. The dam involves some 11,500,000 cu. yd. of concrete over 3 times as much as Boulder Dam. Both projects come under the Bureau of Reclamation.


WATER CONDENSED FROM COMPRESSED AIR
LB. OF WATER CONDENSED PER MINUTE IN 1000 C.F.M. COMPRESSOR AIR AFTERCOOLED TO FREE AIR TEMPERATURE
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
100% R.H.
90% R.H.
80% R.H.
70% R.H.
60% R.H.
50% RELATIVE HUMIDITY
40% R.H.
30% R.H.
20% R.H.
10% R.H.
FREE AIR TEMPERATURE
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
25
100
200
300
400
500
600
700
800
LB. / SQ. IN. — GAGE PRESSURE IN AFTERCOOLER
FORMULA:
$Q = A \times B \times C - \frac{(E \times B \times 14.7)}{D}$
Q = LB. WATER CONDENSED PER MINUTE
A = LB. WATER VAPOR PER CU. FT.
B = CU. FT. FREE AIR PER MIN.
C = RELATIVE HUMIDITY OF FREE AIR
D = FINAL PRESSURE LB. PER SQ. IN. ABS.
E = LB. WATER VAPOR IN 1 CU. FT. OF SATURATED AIR AT FINAL TEMPERATURE AND ATMOS. PRESSURE
DESIGN BASED ON DATA SUPPLIED BY ARMSTRONG MACHINE WORKS

Over 1700 Utility Executives and guests met at the Eighth Annual Convention of the Edison Electric Institute, at Atlantic City, June 3-6.

Utility Industry Ready To Meet Power Demands

MEETING at a time when the whole world is at a great crossroads of history, the Eighth Annual Convention of the Edison Electric Institute at Atlantic City, June 3 to 6, went on record to the effect that the utility industry was fully prepared to meet any demands made on it as a result of the vast national defense program. In a resolution adopted by the whole body, the Institute pledged the willingness and readiness of the members to provide and maintain an ample supply of electric power for war industries.

More than 1700 members gathered for the four day meeting, which, while not spectacular was interesting and, as always, helped to preserve the solidarity of the industry. While pledging the utmost cooperation in meeting national defense problems, the Institute reiterated its desire to meet its problems by private initiative.

In his opening address, Charles W. Kellogg, president of the Institute, said that the Utilities can best maintain an ample supply of power, if left free to use their own judgment, initiative and present position of responsibility.

Quoting from President Kellogg's address, "a strong adequate and willing industry, ready to exert its full powers without loss in time or efficiency in support of its government for national defense, is one of the greatest assets a country can have to prepare for, or to prosecute a war . . . Our government can count upon the availability of an adequate power supply for national defense without the need for expenditures or other special measures on its own account . . . Never in history has any country been so well prepared with power for the production of munitions as is our country today. The excess of our installed generating capacity above the peak demands of our power stations is more than 40 per cent, with new construction under way to maintain that margin above normal growth.

"I am sure I speak the sentiments of every electric utility in this land," said Mr. Kellogg, "when I say that the industry is ready and willing to do its best to aid our government and its armed forces in bolstering the national defense. It did so in 1917 to the limit of its plant facilities and it is ready to do it again, this time with much more ample resources."

Pointing out that the present war has produced a very little increase in the electric output of Canada and none at all in England, Mr. Kellogg calculated that the entire war munitions load of the last war today would be equivalent to only 8 per cent of the present annual output of the electric light and power industry.

The Practical Way Out

At the same opening session at which Mr. Kellogg presented his address, Charles E. Wilson, the president of the General Electric Co., set forth his views for the eventual reconstruction of the world. This, he felt, could best be accomplished by the methods of enlightened business. His address was entitled, "The Practical Way Out."

Likening the elements of a dispute between government and business, or between nations at war, to those involved in such local problems as strikes, he asserted that in each instance a satisfactory settlement called not merely for an impatient or passive tolerance, but for the maximum of consideration and appreciation of the opposing interests and viewpoints. America and American business can best contribute to the ultimate peace and harmony of the world by managing their own affairs peacefully and harmoniously. "In our national economic affairs," said Mr. Wilson, "we simply must reach a better human understanding so that the productivity of the industrial machine, which all have helped to create, may be greatly increased and kept running smoothly . . . We cannot rea-

The great Atlantic City Auditorium was cool, spacious and comfortable.

sonably expect to inspire confidence in the court of world opinion unless we can approach it with a record of success in our own democracy.

"Industrial and scientific proggress will continue," he said, "despite the present chaos and disillusionment because society is forever clamoring for things that will make it better, but there must be brought in a new understanding of human relations. Business has been a great civilizer—it can be a better one."

Expressing faith in the processes of American democracy, Mr. Wilson professed his belief that what finally happens in this country is never what any one individual, group, lobby or party desires. Invariably the ultimate result is a blending of many conflicting forces and an inevitable compromise of interest and wills . . . The pendulum always swings past the center.

Economic Trends in the Electric Industry

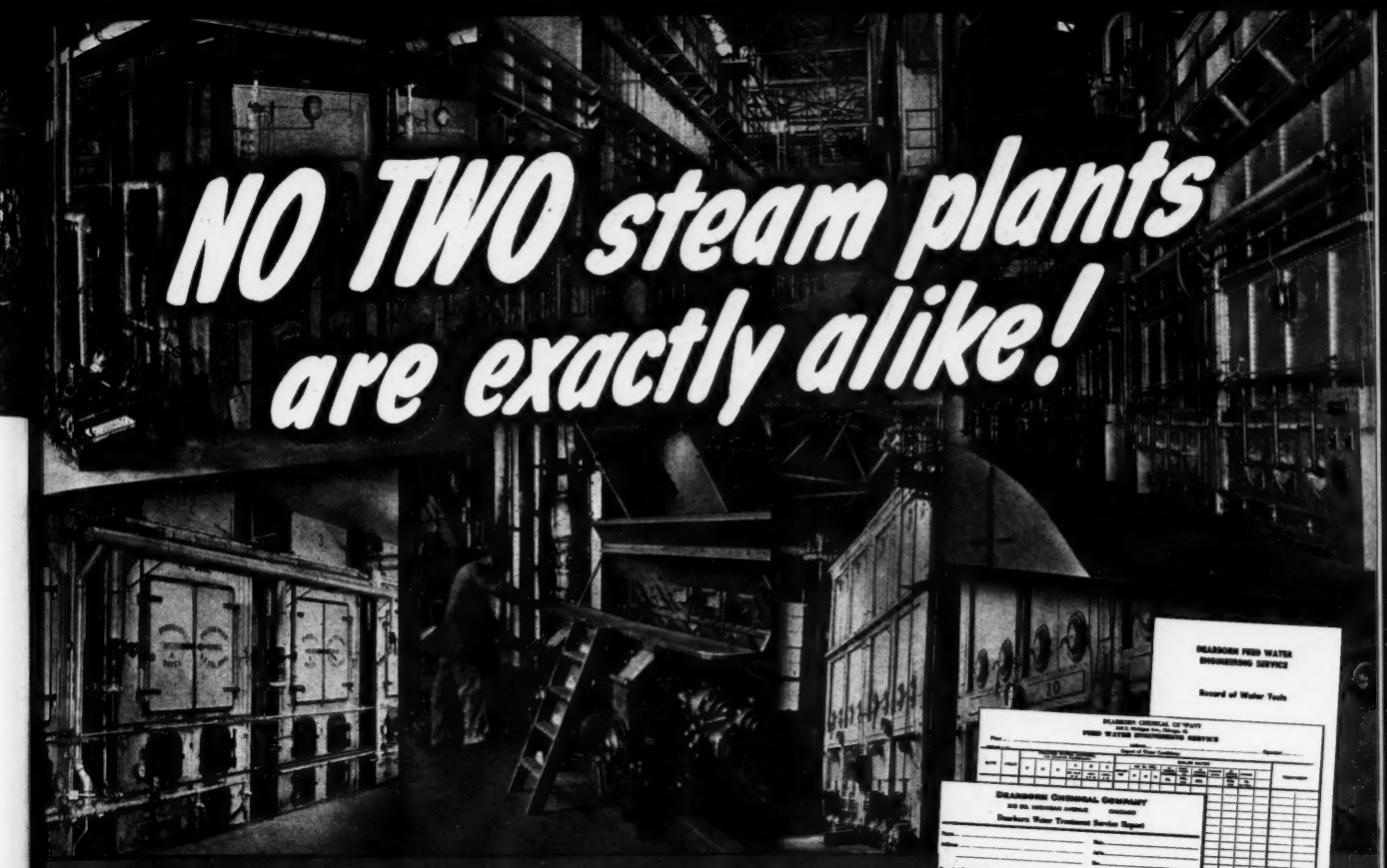
Edwin Vennard's address on Economic Trends in the Electric Industry was reassuring but he pointed out that certain dangers must be avoided. The financial position of the industry, he said, is sound, but this position can be maintained only if the current trend of net revenues is changed. Although the increased use of electricity brought a rise in the gross revenues of utilities of 27.8 per cent between 1933 and 1939, the net revenue increased only 15.7 per cent. Rapidly mounting taxes, diminished opportunity for operating economies and accelerated rate reductions combined to bring about this disparity according to Mr. Vennard.

Although the trends of operating costs has reached the point of leveling off, he pointed out that the trend of rates has continued downward. Most of the reductions in recent years have been made not because of excessive earnings, but on the theory that such decreases would result in increased net revenues and increased percentage of return on investment. This mass-production principle of lowering unit costs by raising volume is applicable to the electric utilities as it is to other industries but the speaker warned that "it is always possible to carry the principle of reducing prices to a point where they go below the incremental costs of making and delivering the additional commodities or services."

More and More For Less and Less

Of interest to those in the industry responsible for the technical advances in the art was the address of H. L. Wallau, Chief Electrical Engineer of The Cleveland Electric Illuminating Co. He reviewed the marked advance in the invention, design and efficiency of electrical equipment of all kinds during the past decade despite the drastic changes in the economic economy. Electrical energy, he pointed out, has continued to become more closely associated with every phase of human activitiy. The recession, he said, permitted the industry to review its situation, plan new ways of regaining lost business and now the losses have been offset and further gains achieved. The decreasing revenues which began to be manifest in the early thirties, coupled with subsequent pressure for lower rates and ever mounting taxes, made it imperative that every avenue of decreasing the delivered cost of both kilowatts and kilowatt hours be explored. The greatest immediate gains, Mr. Wallau showed were in the reduction of costs of generation. These have progressed to a point beyond which in general future gain will become increasingly difficult. Further reduction in expenditure, he said, would have to be largely in the field of transmission and distribution.

The weather and the ocean was "swell".



NO TWO steam plants are exactly alike!

For economical operation and dependable results, correct treatment and control must be used

Dearborn Treatment and Service is designed to fit the special operating conditions of the individual plant. This individualized service is the result of years of field experience and laboratory research. The Dearborn method is being successfully used in thousands of plants under widely different operating conditions.

For up-to-date feedwater conditioning, use Dearborn.

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Dept. F, 310 S. Michigan Ave., Chicago

DEARBORN TREATMENT
is prescribed
for your individual needs

Dearborn
TRADE MARK REGISTERED

WATER TREATMENT
AND ENGINEERING SERVICE

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Few hats were worn on the boardwalk.

Power Generation Advances, specifically, were discussed in a paper by that title by E. L. Hopping, Mechanical Engineer of the Philadelphia Electric Co. He presented statistical data showing how the utilities had met the 10 yr. challenge of lower rates and competitive and restrictive legislation by a continued increase in capacity with improved economy. From a total installed capacity of 29,558,000 kw. in 1929 the utility industry had grown to an installed capacity of 37,446,000 kw. in 1939, a 26.8 per cent increase. Similarly, the generated output during that time had increased from 90 billion kw-hr. to 122 billion in 1939, a 35.9 per cent increase. Fuel consumption had dropped from 1.69 lb. per kw-hr. in 1929 to 1.39 lb. per kw-hr. in 1939 or 18 per cent reduction. In dealing with the specific improvements he discussed such things as boiler gage glasses, steam scrubbers, mechanical draft equipment, hydrogen cooling, gas turbines, etc. His paper was most complete and in itself forms a valuable record of progress.

Distribution Meets Its Responsibilities

The Distribution elements of the Utility Industry were considered in a well prepared paper by H. P. Seelye, senior engineer of the Detroit Edison Co. He said that the cost of distributing electrical energy is not out of line with distribution costs for other products. Including commercial costs (metering, billing, general expense, etc.), it accounts for 65 to 70 per cent of the retail price. This compares with 50 per cent for breakfast cereals, 82 per cent for raw cabbage and the average for all commodities in this country at 59 per cent. He emphasized the fairness of this proportion by citing the fact that in a large electric system, facilities for delivering power from the generating plant to the residential customer account for more than 70 per cent of the investment required. He emphasized also the importance of distribution facilities from the viewpoint of public relations, pointing out that poles and wires come into the residential customer's back yard and service equipment is attached to his house. For this reason he suggested that it was worth while to make distribution structures attractive and harmonious with their surroundings. Finally, Mr. Seelye stressed the need for careful study in design and especially in the establishment of general standards. A mistake in deciding on a standard is multiplied many times over and it may be years before it becomes evident and can be corrected. He recalled that in the Detroit system eventually it was found unnecessary to cut the tops of poles to a peaked roof. Although the saving amounted to only 15 cents per pole, on a total of 30,000 poles a year, the aggregate saving was $4500.

Tiffiny Service and John Q. Public

H. R. Woodrow, vice president of the Consolidated Edison Co. of New York, presented the question of service and cost from quite a different standpoint than that of other speakers. He counselled utility executives to consider most carefully any proposed type of construction or system which might increase fixed charges or operating costs. Electricity consumers in this country, he said, have been educated to a "Tiffiny" quality of service and in their efforts to make electric service more reliable the utilities have in some instances spent more for such protection from service interruption than the increased reliability is worth to the consumers. In other words, "Tiffiny" service costs more than John Q. Public wants to pay." "We have done a lot of bragging in this business," said Mr. Woodrow. "Most of it has been justified since we have a right to be proud of our accomplishments but in our enthusiasm we have been carried beyond a sound economic position. . . . We have been emotional, rather than objective about it."

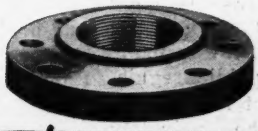
Discussing the experience of customers, Mr. Woodrow related the story of the salesman who described glowingly the advantages which a small factory would receive by installing network service. But the only interruption of service under the old radial system the factory's engineer could recall was one nine years before, on a Sunday morning. Five years after the discussion the factory took the new network service and was interrupted during the first week of service. "All we could say to him," said Mr. Woodrow, "was that if the theory of probability worked properly in his case, he should not have another interruption in 500 years. He (the customer) said just what you (the audience) are thinking."

The American Way of Work

Citing the results of scientific research and the accomplishments of American industry, Ralph Kelly, vice president in charge of sales of the Westinghouse Electric & Manufacturing

DROP FORGED FOR SAFETY AND ECONOMY TO MEET THE MOST TRYING CONDITIONS

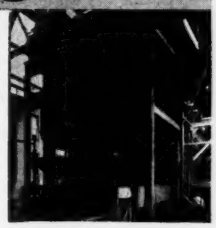
Valves, Fittings and Flanges by Vogt — the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.



Vogt PRODUCTS are

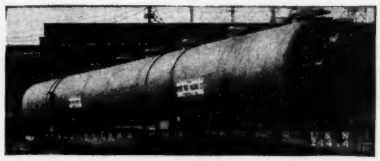
HIGH OPERATING EFFICIENCIES AND LOW MAINTENANCE COSTS

More steam per dollar of investment—because Vogt Boilers are designed and built to fit in with specific operating conditions. Available in bent tube, sectional header, box header and return tubular types using coal, oil, gas or waste heat for fuel.



DESIGNED to RAISE

MEETING THE DEMANDS FOR OPERATING SECURITY

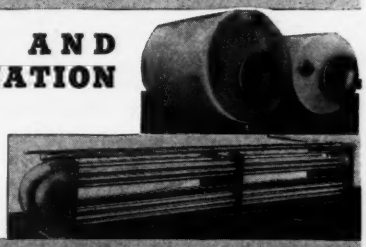


Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

OPERATING STANDARDS and

TO COMBAT CORROSION AND PREVENT PRODUCT CONTAMINATION

Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.



LOWER YOUR COSTS

STEPS TONNAGE UP AND COSTS DOWN

Our experience of more than a half-century in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries and related industries.

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CLEVELAND
CINCINNATI
ST. LOUIS
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DALLAS

HENRY VOGT MACHINE CO., INCORPORATED LOUISVILLE, KENTUCKY

Co., stressed "The American Way of Work" as the most successful and desirable. While the products of inventive genius save labor, they actually create more jobs. Seldom, said Mr. Kelly, does a new product spell doom to its predecessors. It simply creates a new demand or enlarges an old one. Asserting that under the American Way of Work our problem is to give the public the best electrical service in the world and never be satisfied that it cannot be improved. The speaker disclosed that 10 per cent of his company's investment in plant facilities consists of laboratories, test equipment and service facilities devoted almost entirely to the advance and improvement of the electrical art.

Depreciation—What Is It?

The question of depreciation in utility operation was touched upon in a number of papers but the subject was given specific consideration in two papers, one by Samuel Ferguson, president of the Hartford Electric Light Co., and the other by C. E. Kohlhepp of the Wisconsin Public Service Corp.

Mr. Ferguson in his address, which he entitled "Fifth Column Tactics in Original Cost and Depreciation Accounting" characterized as unsound and destructive the methods and definitions being used to promote the "straight-line" theory of depreciation accounting for electric utility companies and that continuation of these methods must eventually result in a lessening of returns to security holders and of surpluses maintained for their protection. He charged that advocates of government ownership were using "fifth column" tactics to induce public regulatory bodies to adopt rules which would cripple the privately owned companies to a point that they would no longer be able to render adequate public service.

In the past, Mr. Ferguson conceded, some companies using the retirement accounting method formerly prescribed by the commission had paid out as dividends money which should have gone into reserves but he denied that this was sufficient reason for changing the straight line depreciation method.

Provided all factors are recognized, there should be no difficulty whatever in reaching a logical and workable agreement in this matter of depreciation, said Mr. Ferguson, but as long as amortization of principle is sought under the camouflage of depreciation, and as long as the elimination of proper acquisition cost is sought in conjunction with the removal of such costs as are improper, just so long will the existing controversy and disagreements continue to plague both the industry and the regulatory authorities.

They say Hitler consults astrologers. The Utility men had plenty of opportunity to take a tip from him, with Prof. Sewards famous establishment right on the boardwalk.

Mr. Kohlhepp in his address also criticized the straight-line "age-life" method of depreciation now favored by many state commissions. Although technical, complex and controversial, the subject of depreciation is of major importance to every utility company large or small, said Mr. Kohlhepp. He warned that superficially convincing methods, testimony and records are being used which may easily have the effect of gaining judicial support for the destructive and unsound straight line theory. Like Mr. Ferguson, Mr. Kohlhepp also admitted that the retirement principle in some instances had led to abuse but at the same time implied that this was no fault of its underlying principles.

Closely related to the addresses by Mr. Ferguson and Mr. Kohlhepp was the talk by Bernard S. Rodney Jr., associate controller, Consolidated Edison Co. of N. Y., entitled "One Way Street." He discussed the reduction in property valuations to "reasonable" figures which some state commissions are now requiring and raised the question of whether the utilities were to be denied the right of including offsetting items of investment which were equally reasonable. If this right is denied, he said, utility accounting will become a "one way street" and the total book valuation will not reflect true worth.

The convention was almost entirely a businss meeting. There were practically no social events and there was only one formal luncheon, the last item on the program. It was at this luncheon on Thursday that Alex Dow of the Detroit Edison gave an interesting talk entitled "Some of My Prejudices." In this talk he traced the rapid development of the utility and showed how private enterprise overcame many obstacles during the period of development.

The usual prize awards were made on Thursday morning by H. P. Liversidge of the Philadelphia Electric Co., the Charles A. Coffin medal, the most coveted trophy of the electric utility industry being awarded to the Washington Water Power Co.

CONTROL
IN POWER PIPING FABRICATION

Pipe bending procedure as practiced in Power Piping Division.

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Optical pyrometer control of temperatures of bending furnaces.

Power Piping Division of Blaw-Knox Company has facilities for every known type of "operations control" which may be specified under the most critical interpretation of current specifications, for use in fabricating high pressure-high temperature piping.

Control in bending with special bending furnaces and optical pyrometers.

Control of grain size checked with photo-micrographs.

Control of annealing with complete automatic chart records.

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Soon ready for publication FLEX-ANAL CHARTS by E. A. Wert and S. Smith, sponsored by Power Piping Division of Blaw-Knox Co.
It is now possible for engineers using this book to figure stresses in high pressure-high temperature piping systems by means of graphs and highly simplified formulae. This book is priced at $3.00 but will be sent gratis to engineers who ask for it on their business letterheads.

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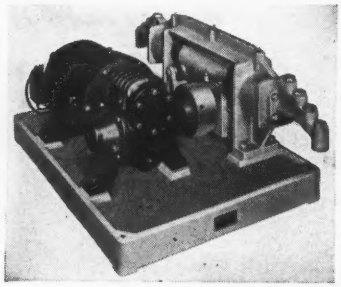
New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Chemical Pump

AN OPPOSED TYPE Duplex Chemical Pump with capacity of 4 gal. per hr. against a pressure of 3000 lb. is now offered by Milton Roy Pumps, 3160 Kensington Ave., Philadelphia, Pa. An explosion-proof, geared motor and pump are an integral unit of exceptionally



compact design. Double-ball check-valve construction for both suction and discharge on pump chambers not only eliminates air-binding but also automatically discharges small particles of dirt and makes pumps self-cleaning. Pump plungers, ball checks and ball seats are all of stainless steel. The entire unit is rugged, mounted on a rigid base.

Improved Sound-Level Meter

GENERAL RADIO CO., Cambridge, Mass., announces the Type 759-B Sound-Level Meter, an improved model of the older Type 759-A.

The new instrument meets the standard specifications for sound-level meters as adopted by the American Standards Association and various engineering societies. It is suitable for use in noise surveys, and for measuring the noise generated by machines and appliances.

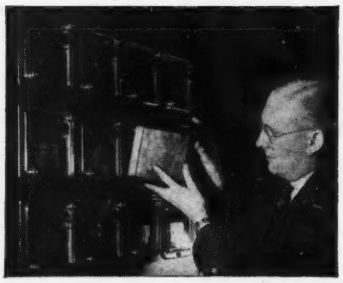
Features of the new instrument are accuracy, rugged construction, convenience in operation, and portability. A two-speed indicating meter with selector switch is provided. In the Fast position of the switch, the meter speed conforms to A. S. A. specifications. In the Slow position, the meter is heavily damped and can be used for measuring the average value of rapidly fluctuating sounds.

New types of vacuum tubes and batteries give reliable operation and long life. The entire assembly is mounted in portable, airplane-luggage type of case. Batteries are self-contained.

The range of the sound-level meter is +24 to +140 db. Provision is made for connecting a General Radio Type 760-A Sound Analyzer for analyzing the noise spectrum.

Plug-In Relays

A COMPLETE line of relays with plug-in construction has been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This makes it possible to remove the completely assembled relay in its case from the switchboard to a more convenient or better equipped location for testing, inspection, or adjustment. The terminals of each relay extends from the rear as bayonet fingers



which engage with the spring-clip receptacles as the relay is pushed into position. By loosening two screws extending through the glass cover, a relay can be removed. The plug-in contacts are so designed that removing the relay from its switchboard position does not disturb any of the circuits to which it is connected. False operation of circuit breakers or open-circuiting a current transformer are prevented by contacts which operate automatically when the relay is removed.

Potentiometer Pyrometer

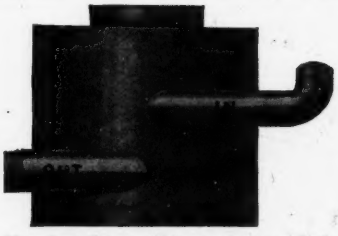
A NEW TYPE of portable potentiometer-pyrometer for measurement of temperatures by thermocouples is announced by J. B. T. Instruments, Inc., 441 Chapel Street, New Haven, Conn. The instrument, Model 70-PO, uses no standard cell, requires very little balancing and is fitted with a sensitive but rugged double pivoted Triplett galvanometer with a 4⅛-in. pointer. A special Triplett micrometer has cold junction compensation inside the case so no adjustment for room temperature need be made; it can be used under ambient temperature conditions of minus 40 to plus 120 deg. F.

An important feature of this instrument as already mentioned is the ease of balancing. With scales of 0-400 deg. F. and higher, once balanced and adjusted the instrument requires no further balancing and thereafter, is read as a deflection instrument. On scales below 0-400 deg. F. one balancing operation is needed for each temperature reading.

The case is mahogany with lustrous natural finish, 6½ by 7½ by 4$\frac{15}{16}$ in., and has a leather carrying handle. The cover is fitted with slip hinges. The panel is engraved Bakelite.

Blow-Off Muffler

A NEW type muffler has been developed by the Sullivan Valve and Engineering Co., 910 South Arizona St., Butte, Mont. This centrifugal blown-down muffler is said to eliminate the disadvantages of a blow-off tank. By its use, steam can be vented in the boiler room or outside through a sheet metal pipe, and the water can be released through an open floor drain or direct to a sewer connection. The blow-down on entering the inlet of the muffler sets up a cen-



trifugal action which separates sludge and water and permits vapor to rise and slowly drift out through the vent. Swirling action keeps the muffler clear of sludge and sediment. The outlet of the muffler being always open prevents the building up of dangerous boiler pressures as sometimes happens in blow-off tanks when the outlet becomes clogged. Two or more boilers may be connected to a single muffler without danger of back pressure being built up on an idle boiler, should a blow-off valve happen to be open.

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Now, a complete range of corrosion-resistant piping equipment is available from stock in the great Crane line. From a wide selection of alloys, you can choose with surety for every condition. There is a Crane material offering highest protective values against chemical impurities for each gas or liquid service.

Crane alloy equipment is not without experience in actual service. Heretofore available on special order only, it has for many years pleased the most exacting users in power and processing industries.

This new Crane line reflects a thorough knowledge of the efficiency of select alloys under varying working conditions. And combining Crane's ability in valve engineering and 85-year manufacturing experience, it assures you of complete satisfaction from every angle.

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. . . and get acquainted with Crane Corrosion-Resistant Valves and Fittings. You'll find it a reliable piping "headache" remedy and a sound money-saving manual. You will find a lot of use for the authoritative colored "Stop & Go" chart which indicates the degree of suitability of each alloy for specific services. Your Crane Representative will gladly supply this catalog—*free*—or, you may use the coupon below to get one.

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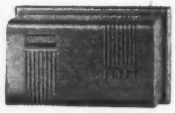
Room Humid-U-Stat

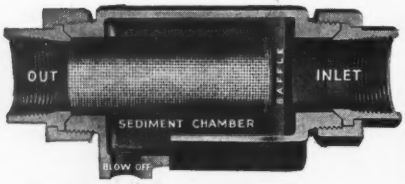
THE NEW H0900 Room Humid-U-Stat, made by the Minneapolis-Honeywell Regulator Co., 2950 Fourth Ave., South, Minneapolis, Minn., is a pneumatic hair element humidity controller designed for wall mounting. It is equipped with a temperature compensator which maintains calibration so that it will control at the selected relative humidity, even though the temperature changes. It may be used



as a direct or a reverse acting control by a simple adjustment. Also, the throttling range may be adjusted on the job to prevent the wide variations in humidity which sometimes result from controls "hunting." The instrument is available in the scale range of 20 to 80 per cent relative humidity with scale markings 20, 50, and 80. The throttling range is adjustable from 2 to 30 per cent relative humidity. The instrument may be mounted flush on a wall box or on the surface of a surfaced box.

Strainer

THE EASYCLEAN STRAINER, made by the Wright-Austin Co., Detroit, Mich., is applicable for steam, air, gas, oil or water. A dirt pocket at bottom of the strainer collects the dirt and scale before reaching the screen. The dirt



held in the pocket is easily discarded through the blowoff, prolonging intervals between cleaning. The screen is a perforated sheet brass having 400 1/32 in. holes per sq. in. The body is of cast-semi-steel, suitable for working pressures up to 250 lb.

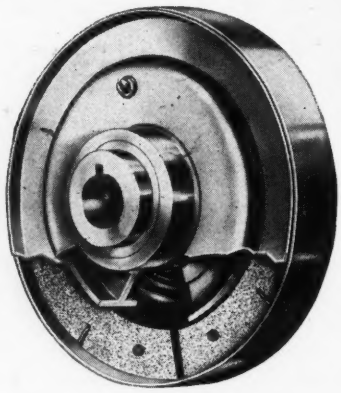
Box Wrenches

BONNEY FORGE & TOOL WORKS, Allentown, Pa., offers a new series of 15 deg. angle wrenches, forged of Bonaloy Steel. Their heads are at angles of 10 to 15 deg. depending on the length of the wrench. Either side of the head may be

applied. Handles are thin and oval-shaped, affording a firm, comfortable grip. They have double hexagon openings, are fully chrome plated and have polished heads. They are made in three sizes with the following openings and lengths: 3/8 and 7/16 in. openings, 4½ in. long; 7/16 and ½ in. openings, 5 in. long; ½ and 9/16 in. openings, 5½ in. long.

Mercury Clutch

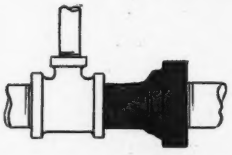
DEVELOPED by Mercury Clutch Corp., Massillon, Ohio, the new Mercury Clutch permits a driving motor to gain speed before assuming load. Utilizing mercury to displace friction segments by centrifugal force, the clutch gradually picks up the load at full speed. Only four principal parts comprise the clutch; the driving



member or housing, the driven member or inner drum, the clutch segments and the mercury, the latter being introduced or removed through filler-holes. In operation, mercury displaces the clutch segments inward, where they engage the drum at the proper time and speed, a positive drive being effected when the speed of the housing and driven drum are synchronized. It is possible to predetermine the time or speed of engagement.

Distributing Fitting

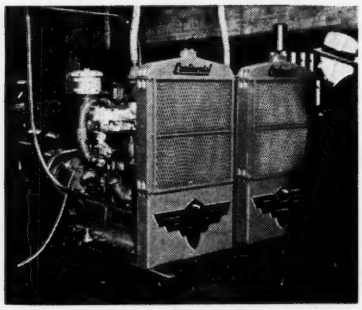
A NEW TYPE of fitting, known as the Sullivan Positive Distributing Fitting, has been developed by the Sullivan Valve & Engineering Co., 910 South Arizona St., Butte, Mont. It consists of a brass casting in which a friction-grip baffle plate is mounted. Adjustment is made by releas-



ing a set screw and turning an adjusting cap. This fitting readily compensates for variation in resistances through radiators and each radiator can be accurately adjusted for the correct water flow. The straight type fitting is installed in connection with a reducing tee leading to each radiator for single pipe jobs and can also be used on the return connection of radiators for balancing two-pipe jobs, either gravity or forced circulation.

Generator Plant

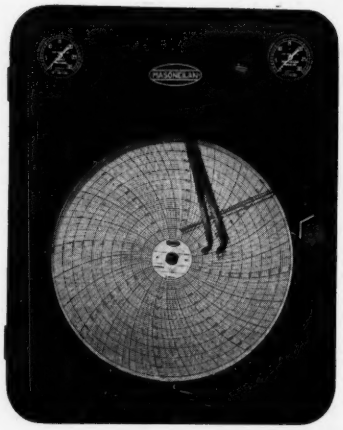
CONTINENTAL MOTORS CORP., Muskegon, Mich., is now offering a 100-kw. electric generator plant powered with two Model 33R overhead valve Continental Red Seal engines. The plant is self-contained for full automatic operation, and the actual load requirements control the starting and stopping of engines. When the operating load is within 50 per cent of its peak, only one engine is operating.



When the load is increased to a point above the capacity of this one engine, the second engine automatically cuts in and picks up its share of the load. The engines may be arranged for operation on natural gas or with straight gasoline carburetion. The drive from the two engines is taken through individual automatic or free-wheeling clutches to a silent chain transmission unit, whence it passes through a common take-off shaft to the direct coupled generator. Each engine can be operated individually and when load is 50 kw. or less, only one engine operates. Furthermore, if either engine needs adjustment or repairs, the work can be done during valley load without interrupting the electric service.

Instruments

MASON-NEILAN REGULATOR CO., Boston, Mass., recently announced new mechanical refinements and restyled cases in their line of indicating, recording and control nistruments. Improvements include a new, more compact, faster, amplifying pilot of high capacity; rearrangement of control assemblies so that all working parts including gases may be installed or removed as a unit; die cast aluminum cases streamlined and finely



proportioned, styled in accordance with advanced mechanical features and the modern trend in instrument panel layout; a new type lock insuring a permanently tight door; time set pointer; rigid aluminum chart plate; aeroplane type nonglare gage dials; straight line, high visibility indicating scale. Features introduced 5 yr. ago—such as universality of control assemblies; interchangeability of standard parts; adaptability to practically any control application; complete adjustability without disturbing chart record or interrupting the control—are retained.

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cooperation that cuts the cost of steam

Many problems were presented by a recently completed public utility steam power plant in which responsibility for valve performance was placed largely in our lap—main steam manifold valves shown below.

We naturally are happy that READING-PRATT & CADY cooperation had its share in the new low costs achieved and assure you equally practical suggestions when you write us about *your* valves.

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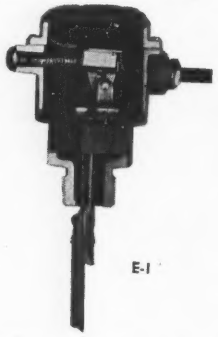
AMERICAN CHAIN & CABLE COMPANY, Inc.

Flow Switch

A SIMPLE new flow switch announced by McDonnell & Miller, Wrigley Building, Chicago, Ill., employs a positive mechanical action to start a pump, an alarm or any electrical device when flow through a pipe starts or stops. Known as the No. E-1, the McDonnell flow switch consists essentially of a long flex-



ible paddle which is extended into the pipe. The paddle arm is connected to the electric switch through a flexible metal bellows which keeps the switch absolutely waterproof. When the paddle is forced back by the flow in the pipe it closes an electric circuit and this starts whatever machinery or valves the switch controls. When flow through the pipe stops, the paddle returns to normal position, breiking the electrical circuit. Reverse acting switches are available.

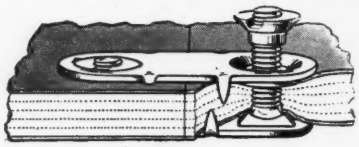
Resilient Pressure Pads

NATIONAL CARBON CO., INC., Cleveland, Ohio, is prepared to supply brushes with a resilient pressure pad secured to the holder end at the point of contact with the pressure finger. The use of these pads materially reduces and may even eliminate such destructive effects as

chipping and cracking of brushes, wear on the holder end of the brush and wear of the pressure finger tip. Within the range of temperature normally encountered on electrical equipment the pad will retain its resiliency throughout the life of the brush. The form of the pad and its exact location on the brush are dependent on the shape and dimensions of the pressure finger and the location of its contact with the brush.

Conveyor Belt Fastener

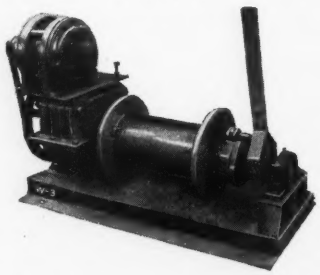
FLEXIBLE STEEL LACING CO., 4607 Lexington St., Chicago, Ill., has added a new size to the line of Flexco HD Belt Fasteners, known as the No. 1¼. They are applicable for joining elevator and conveyor belts from $\frac{5}{16}$ to ½ in. thick. The holding bolts are large size, yet, because of its short length, the new fastener will travel around pulleys as small as 14 in. in diameter. Metal plates span the



joint on opposite sides of the belt and are drawn tightly together by two bolts through the belting. Bolt heads and nuts are countersunk and the protruding bolts are broken off. The template locates the bolt holes slightly farther apart than the bolt centers of the fastener; when the bolts are inserted and drawn down into position the belt ends are forced together tightly, forming a compression seal that will not let material sift through.

Speed Reducer Winch

THIS new winch, made by Stephens-Adamson Mfg. Co., Aurora, Ill., is furnished in a variety of sizes to handle very small or large capacities. A jaw clutch releases pulling tope when disen-



gaged. The speed of the drum may be determined by simply placing proper size sheave on the motor drive shaft of the Saco sneed reducer, since first reduction of the Saco takes place through adjustable V-belts. Second reduction is through cut steel helical gears inside the cast-iron housing.

Multi-Purpose Tool

ANOTHER reciprocating action tool is announced by H & H Research Co., 1925 W. Buena Vista, Detroit, Mich. With a stroke length of $\frac{3}{16}$ in. this Series C machine develops a 30 to 40 lb. push or pull at the end of the chuck and may be used to file, burr, hone, snag, polish, saw and chip. Under full load it travels at 1250 to 1400 strokes per minute and will handle a ¾ in. square hone on heavy work and a $\frac{7}{16}$ in. one on lighter work and confined places. It is 2¾ in. round by 10 in. long. It is powered with 1/30-hp. Robbins & Meyers series wound universal 110 v. motor and comes complete with built-in toggle switch and 6 ft. of rubber covered cord and plug. It has a gear ratio of 4-1 and gears and bearings of hardened bronze and all working parts of

hardened and polished steel finished to close limits. The chuck has a capacity of ¼ in. round or square adaptor for ⅛ in. capacity, if required.

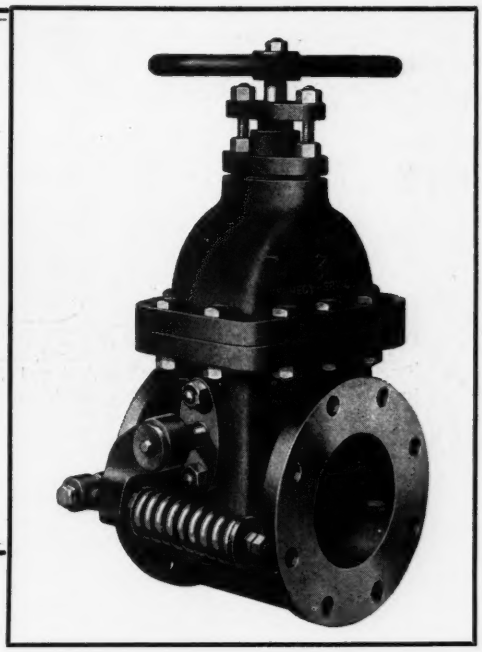
Electronic Pilot Relay

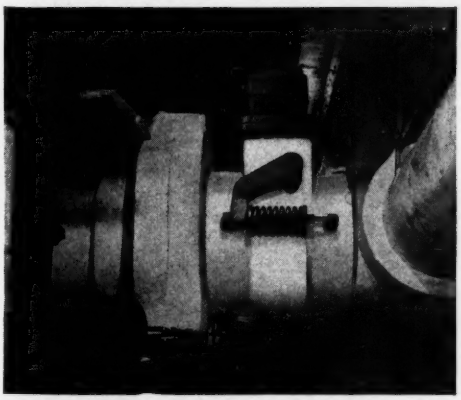
THE PHOTOSWITCH PILOT RELAY, made by Photoswitch Inc., 21 Chestnut St., Cambridge, Mass., is an electronic switch rendering possible control of large currents by delicate mechanisms, liquids, or extremely light contact pressure normally not capable of being used to control electrical currents. Control is effected by

the delicate touching of two fine wires or contacts, or by their being short-circuited by a liquid or even any moist material. Only three millionths of an ampere may in this way control any current desired. This relay is used extensively for automatic liquid level control. It provides positive stop motion control for textile and paper machinery, and monitors automatic feed punch presses, and machine tools.

NICKEL steel alloys, cast and wrought, in crankshafts, connecting rods and cylinder sleeves have made possible compactness, durability and lightness in the air-cooled combustion engines used as power plant for portable pumps and generators built by the Homelite Corp. of Port Chester, N. Y. Pumps have capacity of 8,000 to 35,000 g. p. hr. to handle liquids carrying mud or sand. Electric plants are used for floodlighting, electric tools and temporary or emergency lighting.

Protect Low Pressure Apparatus from Excessive Pressures *with the* . . . . . KENNEDY-ERWOOD *Safety* Swing Gate Valve





Typical installation of the Kennedy-Erwood Swing Gate Valve on the exhaust line between turbine and condenser. An extended stem with floor stand in the turbine room permits convenient hand-operation, and the spring may be set for automatic relief at any predetermined pressure.

This unique design combines the functions of a gate valve, check valve, and relief valve in a single unit. It may be hand-operated as a standard gate valve, and when closed, its adjustable spring-controlled disc will automatically relieve excessive unbalanced pressure in any apparatus or pipe line.

For example, used as a non-return valve on the exhaust line between turbines or engines and condensers or heaters, the Kennedy-Erwood Valve protects the low-pressure casing against building up of pressure which might cause failure and serious damage to equipment or injury to operatives.

Other applications are as a back-pressure valve, atmospheric relief valve, or safety gate valve on pumps, compressors, etc.

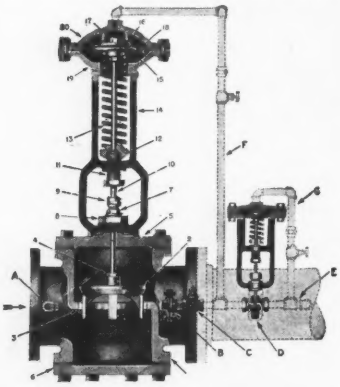
Write for full information on this important aid to greater plant safety.

THE KENNEDY VALVE MFG. CO.
Elmira, N. Y.

KENNEDY-ERWOOD
Safety **SWING GATE VALVES**

Pressure Reducing Regulator

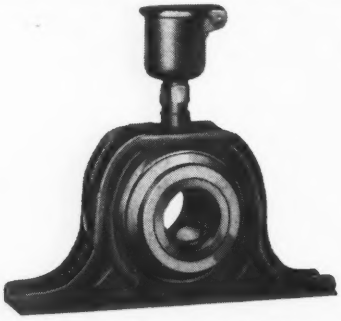
AN IMPROVED pressure reducing regulator, made by The McAlear Mfg. Co., 1901-1907 S. Western Ave., Chicago, Ill., is an auxiliary operated, extremely sensitive valve of single seated construction. This regulator is designated as No. 231.



The main valve of this regulator comes in either direct seated (spring opened) or reverse seated (spring closed) as desired. In operation, the main valve, when direct seated, is held open by spring tension and closed by inlet pressure on the diaphragm. The pilot valve is installed in the bleed-off connection of the main valve diaphragm, with a line from the reduced pressure side connected to the pilot valve diaphragm. Fluctuation in reduced pressure causes the pilot valve to open or close, thus varying the pressure on the main valve diaphragm and, in turn, maintaining the pressure for which the valve is set.

Pillow-Block

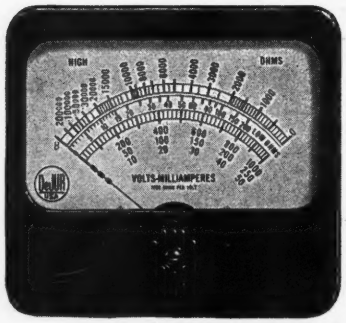
RANDALL GRAPHITE PRODUCTS CORP., 609 W. Lake St., Chicago, Ill., has developed and announces a new, larger pillow block of unique patented design which results in a quiet, light-weight, low priced bearing that is simple yet sturdy. The



entire assembly, consisting of only three parts, the one-piece steel housing, a new machined cast-iron ball with large oil reservoir, and a patented bronze bushing with graphite filled grooves to provide ample lubrication, is cadmium plated to resist corrosion, and is assembled, ready for use without adjustment.

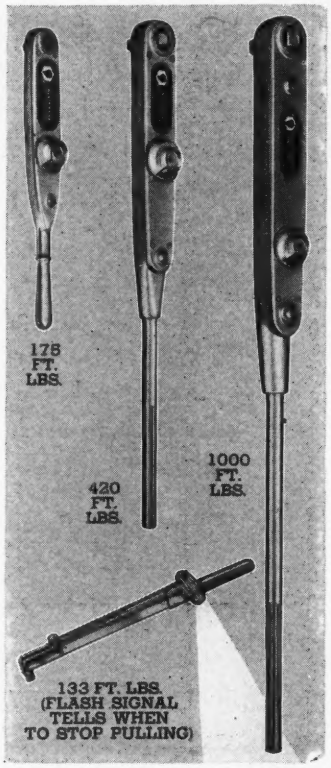
New Meter Line

THE DEJUR-AMSCO CORP., Shelton, Conn., is now in production on a complete line of DeJur ammeters, milliammeters, microammeters and voltmeters in 2, 3 and 4 in. sizes, round and square cases. This line is primarily intended for manufacturers of radio, recorder, transmitter, service and miscellaneous electrical equipment.



Torque Indicator

BLACKHAWK MFG. CO., Milwaukee, Wis., after 2 yr. of experimental research has just announced a new line of torque indicators. The Torkflash Tension Wrench is applicable wherever tensions do not exceed 133 ft.-lb. In using this wrench the desired tension is preset on

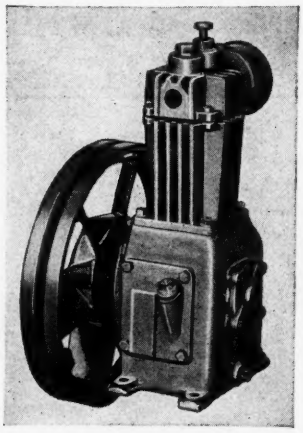


the 5-in-1 tension scale which indicates in in.-lb., ft.-lb., spark plugs and U.S.S. and S.A.E. bolts. A unique light feature signals when the proper tension is reached. This type is offered in two models, No. 39975 having 7/16 in. square drive and No. 49975 having ½ in. square drive.

Three heavy duty tension indicators are included in this line. The No. 49969 with ½ in. square drive having a capacity of 175 ft.-lb., the No. 69969 with a ¾ in. square drive having a capacity of 420 ft.-lb. and the No. 89969 with 1 in. square drive having a capacity of 1000 ft.-lb. All three indicators are of the same design. The spring steel shaft actuates the dial which magnifies deflection 26 times. After tension is released the stay set dial carries the reading of the maximum torque. This dial is reset to zero by turning the center knob.

Air Compressor

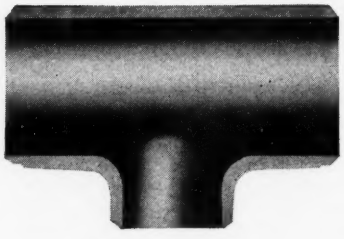
SULLIVAN MACHINERY CO., Michigan City, Ind., is now offering a group of compressor units known as Type "Q". The units are air cooled—single and two stage—and range in capacity from 2.8 to 45.7 c.f.m., ½ to 10 hp., with operating pressures (continuous) 100 to 200 lb. and (intermittent) 150-500 lb.



These compressors have cushioned air valves, balanced crankshaft, taper roller main bearings, Lynite connecting rods, semi-steel pistons, positive lubrication, copper intercooler, chrome nickel cylinders and dust-proof crankcase.

Welding Tee

A NEW line of seamless steel welding tees has recently been developed by Tube-Turns, Inc., Louisville, Ky. Full pipe strength is attained through the proper placing of metal at points of higher stress. This new tee design provides



substantially more metal thickness at the crotch. The thickness along the top centerline of the run of the tee is gradually reduced to normal at the bottom of the tee where stresses, when reinforcement at more highly stressed points is ample, again reach normal. Longer outlets are provided for greater ease in lining up and welding.

There's more to POWELL QUALITY than meets the BUYER'S EYE!

● Beginning a Series of Advertisements to Record Pictorially the Underlying Qualities Originating Within Our Walls Which Make Powell Valves the Accepted Standard in Power Plants Throughout All Industry

How frequent it is that you hear a product referred to as *"quality—through and through!"* Yet how seldom is a buyer given specific *evidence* that any more than the superficial quality which he can actually *see* in the product justifies such a claim.

In Powell Valves, very definitely there are *hidden* qualities resulting from constant improvement in materials, design, and workmanship which play a major, but not always fully appreciated, part in assuring an extra margin of service under the abnormal conditions to be found in both large and small power plants.

In order to make these qualities as readily apparent as any other Powell feature . . . and to put them right at your finger-tips for easy future reference . . . we will use the pages of this publication each month to take you into the very departments of our plants where the inherent superiority of Powell Valves originates.

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

POWELL VALVES

THE WM. POWELL COMPANY • CINCINNATI, OHIO

STOP

OIL SEEPAGE!

PACK WITH BELMONT

End that drip drip drip! It's a profit eater —a fire hazard—exposes all your operations to possible loss.

Belmont 6100, illustrated above, is especially designed for use on rods and valve stems handling volatile distillates. Gasoline, naphtha, kerosene and benzol tend to break down ordinary lubricants. But Belmont 6100 uses a *special* lubricant (our exclusive formula) that keeps it soft, retains its sealing qualities longer. The fact that many of the largest refineries use Belmont 6100 is proof that it does the job better.

6100 is just one item in the complete line of Belmont oil packings built to give maximum performance in all types of oil service. Belmont also makes packings for other services. And each Belmont Packing is constructed for ultimate wear and greater efficiency.

The complete line of Belmont Packings (for all types of services) is described in detail in the new FREE 1940 Catalog. Write for it on your company letterhead today!

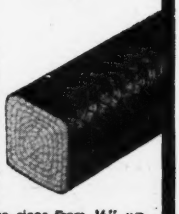
Suggested Belmont Packings For Oil Service

BELMONT 6100

Gasoline Packing. Made of high grade asbestos yarn, braided jacket over jacket. Special lubricating compound keeps packing soft and retains sealing qualities even when applied to volatile distillates. Square cross section. Available in 1, 3 and 5 lb. spools and in sizes from ⅛" to ⅜"

BELMONT 189

Hot Oil Asbestos Packing. Long fibre asbestos yarn, braided jacket over jacket. Oil penetration and saturation minimized by a special formula lubricant. Designed for use on either hot or cold oil rods and plungers. Square cross section. Supplied in packing space sizes from ⅛" up



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Helpful Bulletins

BOILER PLANT EQUIPMENT

1 Stoker — Bulletin 10 describes a stoker that has an easily adjusted fuel feeding mechanism, an adjustable retort depth, controlled overfire air, zoned air control, and stresses the importance of having fuel burning equipment that is adaptable to different grades and sizes of coal and other fuel. American Engineering Co.

2 Oil Burners—A new 4-page folder illustrates and describes Enco fuel oil pumping and heating systems. Specifications for Enco oil pumping and heating units for heavy oil service are included in the folder. The Engineer Co.

3 Combustion Meter—The Hays Corporation announce a new 16-page catalog on Combustion Meters. The booklet, publication No. 40-297, gives valuable information on the relationship of carbon dioxide to efficiency of combustion and explains in detail the operation of automatic Orsat gas analyzers. It is well illustrated with diagrams.

4 Walls and Arches—The Furnace Economy Co. has just issued a new 16-page catalog illustrating and detailing the advantages of their sectionally supported insulated and ventilated walls and arches. This booklet gives complete design and application data and pictures on the Economy Line.

5 Dust Collection—Many answers to modern plant operation problems will be found in "Dust Collection" and "Fly Ash Control," two informative booklets issued by Buell Engineering Co.

6 Spreader Stoker—A 32-page catalog descriptive of the Detroit Roto-Stoker, built in both the hand and power operated dumping grate type and stationary grate type, is available. It contains interesting data regarding the design and performance, together with a number of typical application drawings of installations burning coals of widely varying characteristics, together with reports from various users in different parts of United States and Canada. This stoker is of the Overfeed Spreader Type.

7 Boiler Insulation—A new Detrick catalog shows construction, applications and heat transfer curves on "Thinsulite". This improved type of thin, insulated suspended walls and arches is suitable for boiler walls, water wall backing, oil still furnaces, stress-relieving furnaces. M. H. Detrick Co.

ELECTRICAL EQUIPMENT

8 Aluminum Busbars — Illustrated 32-page booklet describes the conductivity, resistivity, weights, carrying capacities, etc., of aluminum busbars as used in modern power houses and substations. Aluminum Company of America.

9 Switchboard Instruments—General Electric Co. Complete line of rectangular switchboard instruments is described in bulletin GEA-1758B. These include ac ammeters, voltmeters, wattmeters, power-factor meters, frequency meters, dc ammeters, and voltmeters.

10 Renewable Fuses — Illustrated folder issued by Ware Brothers describes Hi-Lag renewable fuses which absorb momentary surges and overloads occurring during starting of some types of motors.

HELPFUL BULLETINS

Many useful engineering bulletins and catalogs are offered in the news and advertising pages of POWER PLANT ENGINEERING. For your convenience we publish the following summary of such literature mentioned in this and recent issues. To obtain copies of these bulletins and catalogs described simply indicate the paragraph numbers on the card below, detach and mail.

11 Distribution Transformer—Allis-Chalmers Mfg. Company's new bulletin, B-6096, tells the story of their latest distribution transformers as built at their Pittsburgh Works in ratings of 1½ to 25 kv-a. and standard voltage classes from 2400 to 7620 volts. This 16-page profusely illustrated booklet not only shows and describes the principal design features, but by a series of construction pictures, shows just how they are built into these transformers during manufacture.

12 Fluorescent Luminaires—A new four-page illustrated booklet, F-8500, describing a twin lamp fluorescent RLM type luminaire contains a complete written description of the fixture, including spread and cut-off values, and its operating power factor. Design data including distribution curves, dimensional sketches, and a table giving calculated foot-candle intensities obtained with various spacing arrangements and mounting heights is given in the booklet. Westinghouse Electric & Mfg. Co.

13 Vertical Contacts — Booklet entitled "Dust the Destroyer" tells how to eliminate dust from between faces of contacts on motor controls, and graphically explains how to get rid of dust by using vertical contacts. Cutler-Hammer, Inc.

INSTRUMENTS AND CONTROLS

14 Combustion Control — Bulletin 102-B describes complete combustion control system designed toward increased combustion efficiency, decreased fuel costs, and reduced furnace maintenance. Bailey Meter Co.

15 Cooling Controls—Sarco Co., File No. 197 covers all types of cooling controls made by company. These include recirculating controls, throttling controls, and refrigeration controls, all operating on Sarco liquid-expansion system.

16 Mechanical Flow Meter—Bulletin No. 110 describes and illustrates a new ring-balance meter for measuring the flow of all types of liquids and gases at pressures up to 2500 lb. per sq. in. Republic Flow Meters Co.

17 Liquid-Level Control — Fred H. Schaub Engineering Co., 4-page booklet No. 140 describes "Magnetrol" liquid-level-control system, which provides 5 point control including low-water cut-off, high-water cut-off, low-water alarm and high-water alarm.

18 Gyrometer — Giving specifications and sizes, bulletin No. 120 describes this device for integrating the flow of any fluid, whether liquid or gaseous. Simplex Valve & Meter Co.

19 Pyrometer — Broadside N-33 — Micromax and other L&N Pyrometers — describes instruments for use with thermocouples, Rayotubes and Thermohms . . . from simple hand-operated temperature indicators, to automatic control equipments capable of handling the most complicated of regulating jobs. Leeds & Northrup Co.

20 Boiler Room Instruments—A new 18-page catalog entitled Brown Boiler Instruments, illustrates and describes the use of CO_2 meters, pyrometers or thermometers, recording thermometers, flow meters, water level recorders, steam flow meters, pressure gages and draft gages. The equipment is described in detail and specifications are given. The Brown Instrument Co.

MECHANICAL TRANSMISSION

21 V-Belt Guide—Horsepower ratings for multiple belts are among the features contained in a 96-page "Guide to Efficient V-Belt Practice." A full-size book, it is illustrated with photographs in color, diagrams and charts. Multiple and fractional h.p. V-belts are both included in this handbook. L. H. Gilmer Co.

22 Belting Calculator—J. E. Rhoads & Sons slide-rule type calculator enables user to calculate belt speed, if diameter of pulley and r.p.m. are given; figures h.p. per in. of belt width over type of belt; figures belt width when h.p. is determined.

23 Rolling Bearings — New bulletin A-325 contains interesting data on the new Dodge-Timken line of rolling bearings designed to give 30,000 hours of trouble-free service. Conveniently arranged tables will aid you in selecting the correct size and type for your requirements. Dodge Mfg. Corp.

24 V-Belt Drives—Illustrated bulletin contains tables and data for computing proper size of V-belt drives for different classes of load. Manheim Mfg. & Belting Co.

PIPING, VALVES AND FITTINGS

25 Valves—Reference Book No. 38 superseding all previous issues illustrates and describes all valves and other Homestead products giving dimensions, weights and prices. Construction and applications are also included. in this 48-page book. Homestead Valve Mfg. Co.

26 Alloy Tubes — Technical Bulletin No. 12-A, Condensed Technical Data on High-Temperature Steels, contains revised useful information and technical data on B&W Seamless Alloy Tubes and Pipe for High Pressure and High Temperature Services. The Babcock & Wilcox Tube Co.

27 Gasket Service—New 64-page catalog No. 48 illustrates and specifies all of the equipment essential to securing 100 per cent joint efficiency. Goetze Gasket & Packing Co., Inc.

28 Separators—A new 8-page Bulletin, Publication 2950, on baffle-type moisture and oil separators contains cross-section photographs and line drawings of the three popular types of line separators. Complete design, dimension, and constructional data is given with list prices. Data on proper drainage, gage fittings, and auxiliary equipment is also given. Cochrane Corp.

29 Valves — Fairbanks Co. 4-page leaflet describes Fairbanks bronze gate valves, with cutaway drawings showing construction and tables giving list prices and dimensions.

30 Expansion Joint—A revised 8-page illustrated Bulletin No. 35-20A on the Adsco Internally-Externally Guided Expansion Joint in sizes from 1¼ to 20 in. gives specifications, dimensions, weights and list prices. American District Steam Co.

31 Valves—W. H. Nicholson & Co., 4-page bulletin No. 933 covers 2-, 3-, or 4-way multiport, metering, and distributing valves for air, steam, oil, gas, tar or water for pressures up to 300 lb.

32 Pipe Tools—A new 24-page catalog gives a description of the complete line of Beaver pipe tools. The newly developed No. 71 Pipe and Bolt Threader is completely illustrated and described. Beaver Pipe Tools, Inc.

Indicate the literature you want on reverse side of this card. No postage needed.

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33 Flexible Tubing—Bulletin No. 70 issued by Pennsylvania Flexible Metallic Tubing Co. contains helpful engineering data on use of flexible tubing for exhaust lines; also connections for oil, water, etc.

34 Automatic Strainer — Illustrated bulletin describes highly efficient automatic strainer which continuously and automatically removes suspended solids from liquids, assures clean effluent and cleans itself. H. A. Brassert & Co.

35 Regulator Service Chart — Quick selection of the proper pressure reducing valve for any kind of service on steam, gas, air, oil, or water lines is afforded through a handy chart of 18 available designs and table of recommended operating conditions. Pressure ratings, type of valve loading, means of control, and other pertinent data are listed. Davis Regulator Co.

36 Welded Piping—Data book No. 109 contains 64 pages of illustrations, tables, drawings, charts on the design of expansion loops, flow of fluids, properties of pipe, etc. Also describes new Schedule Number method of designating pipe wall thicknesses—all important dimensions, weights, tolerances, and prices on welded fittings. Tube-Turns, Inc.

37 Valves—New 120-page catalog and data book No. 34 includes descriptions of new line of Elite and Irelite valves in globe, angle, check and straightway types for working steam pressures of 150 to 350 lb. and liquid pressures of 225 to 1000 lb. The D. T. Williams Valve Co.

38 Piping Book—Soon ready for publication, Flex-Anal Charts by E. A. Wext and S. Smith, sponsored by Power Piping Division of Blaw-Knox Co. It is now possible for engineers using this book to figure stresses in high pressure-high temperature piping systems by means of graphs and highly simplified formulae. This book is priced at $3.00 but will be sent gratis to engineers who ask for it on their business letterheads.

39 Gate Valves—A new illustrated 16-page booklet shows how the Lubrotite Gate Valve designs carries Lubrotite lubricant to the faces of wedge and seat, thus insuring a notably easy working, long lasting gate valve. Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc.

PRIME MOVERS

40 Steam Turbine-Generators is the title of Bulletin H-10, a 32-page catalog in color showing typical installations, describing the type and construction of different turbines and turbine generator units, their construction and arrangement with two full page charts for calculating the water rate for condensing and non-condensing units. Elliott Co.

41 Diesel Units—Profusely illustrated literature gives brake horsepower, torque, and fuel consumption curves of the nine standardized sizes of Caterpillar Diesel engines and describes available auxiliaries. Caterpillar Tractor Co.

42 Steam Engines—Bulletin 101 issued by Troy Engine & Machine Co. gives case studies of plants which have reduced power costs with Troy-Engberg steam engines and generating sets.

43 Generator Units—Illustrated bulletin T-113 describes operating principles of Murray turbine generator units. Contains many diagrams; also typical performance chart of extraction mixed-pressure unit. Murray Iron Works Company.

WATER TREATMENT

44 Electro Chemical Feed—An accurate and reliable feed made for apportioning chemicals in wet form at a constant or variable rate is fully illustrated in 8-page Bulletin 2233 giving specifications. The Permutit Co.

45 Water Treatment—A new 36-page pocket size booklet entitled "Boiler Water Impurities and Their Control," by Roy C. Henszey, treats the subject thoroughly. It is divided into four parts and covers the following subjects: Boiler Water Troubles; Boiler Water Impurities; Water Analysis; and Control of Boiler Water. The Henszey Co.

46 Scale Removal—A new 16-page pocket size booklet entitled "Solving the Boiler Scale Problem with Sand-Banum" gives a complete discussion of this product and its use in the treatment of boiler water. American Sand-Banum Co., Inc.

47 Water Softeners — Elgin Softener Corp., Bulletin No. 602, 16 pages, describes types of Elgin softeners, aerator equipment, auxiliaries for present equipment, systems for steam plants, and Elgin Zeolites, including synthetic zeolite. Illustrated.

48 Algae Eliminator—National Aluminate Corp. 4-page bulletin No. 31 describes Nalco No. 21, organic sterilizing agent used to control algae, slime and bacterial growths that form in water used for industrial purposes.

49 Boiler Treatment—A new 16-page booklet by Garratt-Callahan Co., explains how protective colloidal film of Magic boiler treatment helps prevent scale from adhering to shell and tube surfaces, checks, pitting and corrosion, removes oil and grease.

50 Zeolite Softening — 24-page Bulletin No. 2860 consists of a well-written explanation of zeolite softening processes together with complete descriptions of apparatus required. Tabulated data and charts permit calculation of list prices for any desired installation. Cochrane Corp.

51 Silica Removal — New illustrated bulletin describes how Allis-Chalmers Mfg. Co. has developed Silimite, a special form of activated lime containing magnesia, which is highly effective in removing silica in hot process softeners for boiler feed water. The calcium content of the lime is utilized in softening while the other constituents are effective in silica removal.

FANS, PUMPS AND COMPRESSORS

52 Compressors — De Laval Steam Turbine Co.,Trenton, N. J. 52-page catalog F on centrifugal blowers and compressors contains information on construction with characteristics, turbine and motor drives, properties of gases and laws of compression, and a section on calculating pressure drop in piping.

53 Pumps — Bulletin 5135 illustrates and describes the construction and operation of F-M Rotary Pumps, including data on single pumping units, multiple pumping units and builtogether pumping units. Fairbanks, Morse & Co.

54 Compressor — Worthington Type LTC angle gas engine compressors are described in Bulletin L-600-B10. Catalog H-620-B18E gives detailed descriptions of the complete line of Worthington air compressors. Worthington Pump & Machinery Corp.

55 Draft Fans—A 34-page American Blower Corp. bulletin, No. 3624, describes important factors to be considered in selecting mechanical draft fans; shows typical performance curves. Also pictures advantages of hydraulic couplings (fluid drives) when applied to forced and induced draft fans and pump equipment.

56 Air Condensation Removal — The Logan Engineering Co. offers Bulletin No. 340 which completely describes and illustrates the Aridifier, a device for removing water, oil, dirt and fine scale from compressed air and gas lines by means of centrifugal force through alternating impellers driven by the pressure within the line.

MISCELLANEOUS

57 Coal—"The Coal Bin of America," 26-page illustrated booklet on origin, mining, distribution and uses of all-purpose bituminous coals produced along Chesapeake and Ohio Railway.

58 Condenser—Ingersoll-Rand Company offers a new Bulletin 2622 describing their cross flow, Type R Surface Condenser designed for high vacuums and high efficiency in small capacities. It shows typical installations with cross-sectional views and structural details.

This card should be filled in completely in order to secure the literature you request. Please indicate only the bulletins you particularly desire.

POWER PLANT ENGINEERING

JULY

Please have the manufacturers send me without obligation the literature indicated by the following paragraph numbers.....

.....

.....

Name..... Title.....

Company.....

Address.....

59 Steam Specialties—"Heat Recovery from Internal Combustion Engines" is the title of a new 16-page bulletin illustrating and describing the use of Sims equipment with Diesel and Gas Engines. The bulletin features a wide variety of installations in the U. S. A. The Sims Co.

60 Iron Cement — Smooth-On Mfg. Co., 40-page pocket-size handbook lists applications of Smooth-On iron cements, for stopping leaks, etc.

61 Building Maintenance—A 68-page booklet of technical information for factory engineers and maintenance men shows how to do hundreds of odd jobs at lower cost with better results. Many ideas that save valuable time and materials are presented. Flexrock Co.

62 Refrigeration Cost—"How to Cut Refrigeration Cost." An 8-page illustrated educational bulletin published by Armstrong Machine Works. Discusses effect of air in refrigeration systems and outlines methods for eliminating air.

63 Force Feed Lubricators—Catalog 25-C describes positive lubrication by automatic means, a line of force feed lubricators which delivers the oil where and when it is needed in the right quantity and without guesswork, waste or uncertainty. Manzel Brothers Co.

64 Electric Vibrators — Newly issued 8-page Bulletin 257 describes application of Syntron electric vibrators to keep coal and ashes flowing freely in bins, chutes and hoppers. Bulletin 252 illustrates vibra-flow feeder conveyors. Syntron Co.

65 Industrial Vacuum Cleaner—Illustrated 8-page Bulletin A-303 tells about portable and stationary vacuum cleaning systems for keeping boiler tubes, motors, line shafting, piping, conveyors, ovens and other equipment free from dust and dirt. U. S. Hoffman Machinery Corp.

66 Laboratory Crushers—New 8-page illustrated folder describes latest types of laboratory crushers and grinders for the reduction of coal, clays, chemicals, limestone, shale and similar materials. American Pulverizer Co.

67 Conveyor Book—A new 48-page, well illustrated Book No. 1700, "Link-Belt Conveyors in American Industry," has been published by Link-Belt Co. Besides picturing many different applications of mechanical elevating and conveying equipment, the book contains several pages of statistics and thought provoking reading matter on the theme that the greater use of machines has placed America in the forefront of all nations.

68 Protective Coatings—New bulletin describes Thur-ma-lox heat resisting coatings for stacks, breechings, flues, fire doors, boiler fronts, superheated steam equipment, etc. No. 7 black withstands temperatures up to 1800 deg. F.; No. 10 aluminum up to 1400 deg. F. The M. W. Kellogg Co.

69 Wire Rope—"American Cable Elevator Wire Rope User's Handbook" is the title of a new 40-page book recently issued by the American Cable Division, of the American Chain & Cable Co., Inc. In every sense of the word it is a "handbook" of constructive information for the building manager and engineer. It illustrates and describes the several different constructions and grades of wire rope commonly used for elevator service.

5′ Leverage ...with SAFETY!

WHEN a man has to "lean" on a wrench and a slip might bring injury—Snap-on Boxockets are the *safe* wrenches to use. They grip the nut on *all* 6 sides—won't slip, won't spread—combine socket wrench "holding-on" power with end wrench "straight line" pull. Especially fast in cramped quarters because these boxockets operate with only half the handle movement of open-end wrenches.

Snap-on makes 24 Boxocket wrench sizes—¾" to 3⅛", available with both straight and offset heads, and with handles providing up to 62" leverage.

Make sure of hand tool safety in your shop—with Snap-on safety-built tools. More than 2200 styles and sizes from which to choose, with warehouses in 35 principal cities. For full information write . . .

Snap-on Wrenches
The Best Tools are the Safest Tools

SNAP-ON TOOLS CORPORATION
Dept. PPE-7 Kenosha, Wisconsin

For Accurate Metering of BOILER FEED CONDENSATE STEAM & AIR

● You need never guess about the totalizations of Boiler Feed, Turbine Condensate, Steam, Air or other fluids when you have a Simplex Gyrometer on the job.

Although low in first cost and maintenance, and designed for use with orifices, nozzles or venturis—the Gyrometer provides an accurate and dependable summary of your plant flows.

It will pay you to find out how the Gyrometer can point the way to increased economies in your plant. Write for descriptive bulletin.

SIMPLEX VALVE & METER CO.
6790 Upland St. Philadelphia, Pa.

SIMPLEX GYROMETER

Manufacturers' News

HAROLD W. WHITING has been appointed Assistant to the Chief Engineer of the Compressor Division of the Worthington Pump and Machinery Corp. He will make his headquarters at the Buffalo Works of the corporation.

PAUL LINDBERG, until recently Superintendent of Rolling Mills of the Steel & Tube Div. of the Timken Roller Bearing Co., has been appointed Superintendent of Rolling Mills of the Steel Div. of the Copperweld Steel Co. His experience consists of over 42 yr. in steel mill work and all capacities from roller to superintendent of rolling mills.

THE MINNEAPOLIS OFFICE and warehouse of Cutler-Hammer, Inc., has been moved to larger quarters at 532 South Seventh Street. According to J. U. Heuser, District Sales Manager with headquarters in Milwaukee, the new Minneapolis location offers more room and better facilities for stocking and handling C-H motor control, safety switches, service control and allied electrical equipment which the Company manufactures.

NATIONAL ALUMINATE CORP. announces the appointment of J. T. Nicholson as Junior Engineer for the Southeastern states. For the present his headquarters will be at Winston-Salem, N. C. He will work under the direction of W. O. Widener.

AMERICAN CHAIN & CABLE CO., INC., announces that the Julian d'Este Co. has been merged with their organization, and its products will be manufactured at the plant at Reading, Pa.

C. K. BRYCE, formerly Manager of Factories, has been elected Vice-President of Oxweld Acetylene Co., a unit of Union Carbide and Carbon Corp., New York.

THE UNIVERSAL GEAR CORP., Indianapolis, Ind., announces the appointment of J. Y. Dahlstrand as director of Sales and Engineering.

THE AMERICAN ENGINEERING CO. announces the appointment of J. S. Bennett as Manager of Sales for the Company and William H. Schultze as Sales Manager of the Marine Division. C. L. Myers will continue as Sales Manager of the Stoker Division.

THE JEFFERY MFG. CO. announces the appointment of Stanley M. Mercier to the position of Chief Engineer, Conveyor Division.

W. L. MARTWICK has been elected Vice-President of the Foster Wheeler Corp. in Charge of Sales.

AFTER twenty years of service, Max F. Becker has been appointed Vice-President in Charge of Sales Representatives of the Whiting Corp., according to announcement by General T. S. Hammond, President of Whiting Corp. He will be in direct charge of field men in the Industrial Division and will direct the activities of Whiting representatives and special agents.

ACCORDING to an announcement by Walter Geist, vice-president of the Allis-Chalmers Mfg. Co., A. I. Richardson has been appointed manager of the district office at Dallas, Texas. He was previously located at the company's district office in Charlotte, N. C., and has been with the company since 1925.

THE LINDE AIR PRODUCTS CO., a unit of Union Carbide and Carbon Corp., announces the election of T. D. Cartledge and L. A. Bliss as Vice-Presidents, and of E. J. Hayden as Vice-President, Central Division, E. B. Suydam, formerly Assistant General Sales Manager, has been appointed General Sales Manager to succeed Mr. Cartledge; and P. B. Pew, formerly Assistant Works Manager, has been appointed Works Manager to succeed Mr. Bliss.

THE EMPLOYMENT service of the Four Founder Engineering Societies has been incorporated in New York and its name changed to Engineering Societies Personnel Service, Inc. At the first meeting on June 10 plans were made to extend the operations of the Service to a greater degree. George T. Seabury, national secretary of the A. S. C. E., was elected president; C. E. Davies, secretary of the A. S. M. E., vice-president; Otis E. Hovey, director of the Engineering Foundation, treasurer; and A. H. Meyer, secretary.

A regional office in Detroit, opening about July 1, will be located in the Hotel Statler until such time as it can move into permanent quarters in the E. S. D. Building, now under construction. Louis E. Williams has joined the staff of the Service and will be manager of the newly established office.

THE ARMSTRONG MACHINE WORKS announces the appointment of Frederick G. Stamm to head a newly organized Paper Mill Division of the company. The new division of Armstrong Machine Works is prepared to render specialized paper mill engineering service in all parts of the United States and Canada, and includes application of Armstrong-Stamm Graduated Dryer Temperature Control, Armstrong-Stamm Sheet Moisture Control, the Armstrong-Stamm Drainage System, and application of various individual products in the Armstrong-Stamm line.

DR. HOWARD A. SMITH has been made chief metallurgist of The Duraloy Co., Scottdale, Pa. Until recently he was research metallurgist with the Rustless Iron & Steel Co., Baltimore, Md., and previously in charge of stainless steel development in the laboratories of Republic Steel Co. at Canton, Ohio.

THE UNIVERSAL GEAR CORP., Indianapolis, Ind., announces the appointment of M. E. Robbins of the New York District Sales Office as Assistant Director of Sales and in direct supervision of all Eastern Sales Districts. His location will be New York City with offices in the Lincoln Bldg., 60 East 42d St.

New Construction

CONTRACT for the largest centrifugal refrigerating machine in the United States has been awarded to the York Ice Machinery Corp. by the Industrial Rayon Corp. This system will be used for industrial process air conditioning in an addition to the present $11,500,000.00 plant of the Industrial Rayon Corp. at Painesville, Ohio. With a refrigerating capacity equal to the melting of 2,000,000 lb. of ice every 24 hr., the machine, a York-Allis Chalmers turbo-compressor, in combination with a York brine-cooling system is also the largest single unit refrigerating system using the refrigerant Freon-11.

The steam-turbine drive will be completely automatic in operation and will use exhaust steam from the generating turbines. Lake Erie water at the rate of 4000 g.p.m. will be used in condensing the refrigerant gases of the York cooling system. This system will cool 2600 gal. of brine per minute to 40 deg. for the new air conditioning equipment, and will be inter-connected with the present brine cooling system to allow flexibility in using steam or electric power to drive the refrigeration systems.

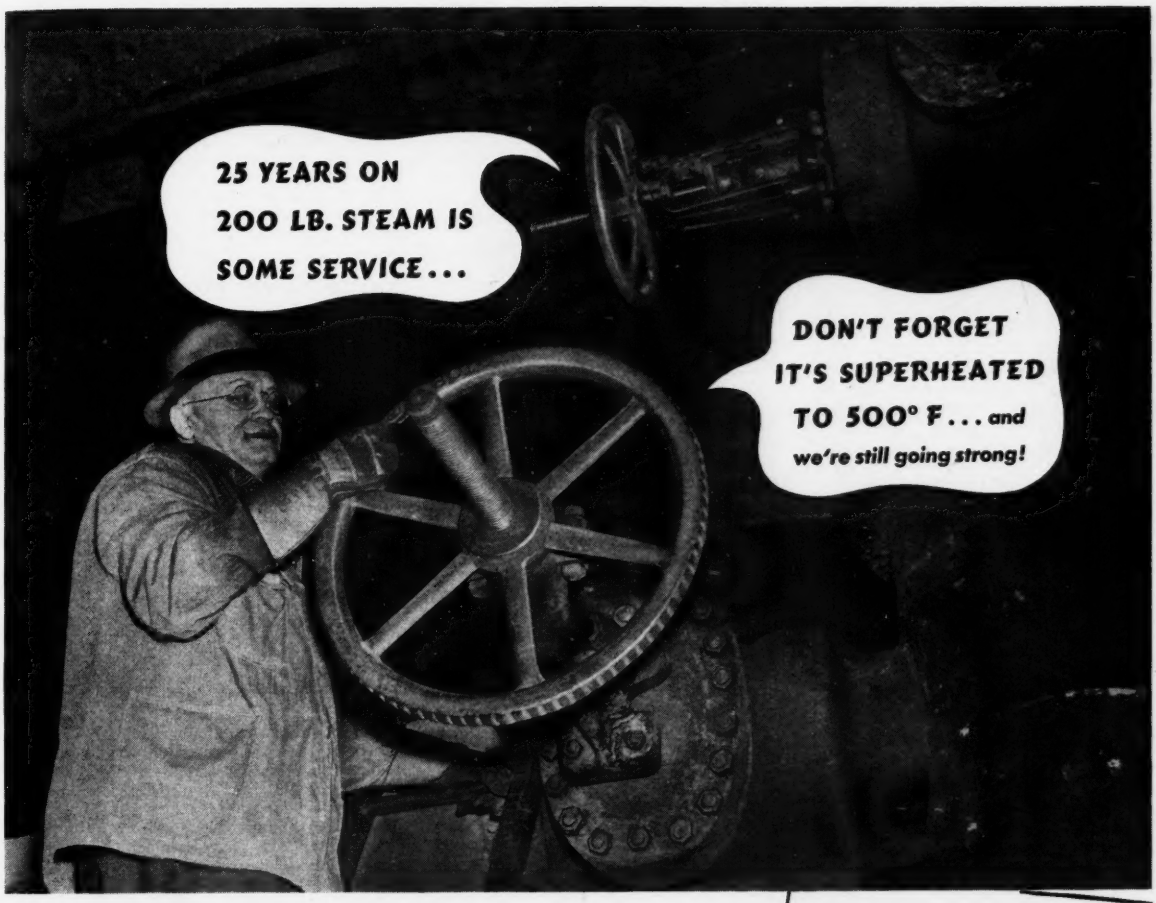
A RECENT contract awarded to Allis-Chalmers Mfg. Co., Milwaukee, Wis., by the U. S. Dept. of Interior, covers four big transformers, totalling $426 000, for the Phoenix Terminal Sub-Station. In physical size they will be among the largest transformers ever built by the Allis-Chalmers company.

When completed, the huge units will take power of 154,000 volts off the transmission line from Parker Dam on the Colorado River in Arizona. To be installed on the outskirts of Phoenix, they will convert this high voltage into lower voltages of 69,000 and 12,500 volts for feeding the power systems of the Salt River Valley Water Users' Association and of the Central Arizona Light and Power Company.

Each of the three-winding, single phase power transformers is equipped with load ratio control, and has a rating of 30,000 kv.a. which, on account of the three windings, is equivalent to 40,000 kv.a.

J. E. SIRRINE & Co., Greenville, S. C., consulting and designing engineers, awarded a contract for automatic coal handling equipment and a coal silo to Fairfield Engineering Co., Marion, Ohio. The contract is part of the engineering firm's plan for power plant modernization for their client, Trion Company of Trion, Ga., manufacturers of sheetings, wristlets and glove jersey cloths, and will eliminate the hand feeding of coal to stokers for the four boilers in the present plant. The installation will include control and recording instruments as well as the necessary building alterations. B. D. Riegel is the president of the Trion Company which employs over 3500.

CONSTRUCTION was recently started on a new 2500 kw. Westinghouse turbine and condenser installation for the municipal plant at Columbia City, Ind.



THIS ENGINEER CAN TELL YOU SOMETHING ABOUT VALVE COSTS

WHEN you buy valves, it usually means there's an old valve, possibly a Jenkins, going out of service. So before the order is placed, why not talk to the engineer who requisitioned it.

Ask him how much the old valve cost *since* it was installed. And then find out how much the valve cost new. Now you are ready to figure initial cost plus cost of maintenance *divided* by years of service... the sound cost-per-year basis on which most Jenkins Valves are bought.

That's how Chief Engineer A. E. Rabuck (shown above) figures costs at Metropolitan Edison Co. Dock Street Plant—Easton, Pa. And if you check his figures on these Cast Steel Valves in the box at the right, you'll see why he specifies Jenkins.

JENKINS BROS., 80 White St., New York, N.Y.; Bridgeport, Conn.; Boston, Mass.; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Tex. Montreal, Canada London, England

"COST-PER-YEAR" of these Jenkins Steel Valves

Fig. 1010—6", 8", 10", 12"
Total of 14 valves on main header

Initial Cost *(14 Valves)* . $4,923.51

\+

Annual maintenance . $12.00

÷

Years of Service 25

=

Cost-per-year (per valve) . $14.92

and they're still going strong!

IN VALVES *Jenkins* GIVES YOU EVERYTHING

For the time being the new unit will operate at 175 lb. pressure on steam supplied from the old boilers but it is designed for 450 lb. 750 deg. F. in anticipation of a new boiler plant in the future. Other changes underway consist of Marley spray equipment, an Elliott feedwater heater and Worthington boiler feed pump. F. T. Schultz is general superintendent and Laramore & Douglass, Inc., of Chicago is the consulting engineer.

HOLYOKE VALVE & HYDRANT CO. has been awarded the contract for the piping for the boiler house construction at Naugatuck Chemical Div. of United States Rubber Co., Naugatuck, Conn. Plans and supervision are being handled by Lockwood Greene Engineers, Inc.

ACCORDING to the consulting and designing engineers, J. E. Sirrine and Co., contract for two multiple retort continuous ash discharge type stokers, part of the boiler room modernization of the Erwin Cotton Mills Co., West Durham, N. C., has been awarded to the American Engineering Co., Philadelphia, Pa. The stokers are for the two new h.p. Babcock & Wilcox boilers. The total installation, including the necessary building changes and auxiliaries, will run in excess of $100,000.

CONTRACTS have been awarded for major equipment and construction started for a new power plant for the Ottawa Silica Co., Ottawa, Ill. The plant will operate with 450 lb., 600 deg. F. steam and will consist of three 35,000 lb. per hr. Bros boilers fired by Bros stokers and two 1500 kw. Allis-Chalmers condensing turbines arranged for extraction at 150 lb. pressure for process use. The new plant will replace an older boiler plant and purchased power and is expected to be in operation about October of this year. W. B. Gyger is plant superintendent and Laramore & Douglass, Inc., of Chicago is the consulting engineer.

Power Projects at Federal Properties

THE BUREAU OF YARDS AND DOCKS, Navy Department, Washington, D. C., has plans under way for power plants at proposed new naval air stations, as well as for expansion and improvements in power stations and facilities at a number of existing such naval bases and navy yards, as provided for in the new Naval Appropriation Bill, recently passed by Congress. Bids for different parts of program are scheduled to be asked soon. The total fund for navy air bases will be $124,000,000. Of this amount $8,500,000 will be used for expansion in naval base at Jacksonville, Fla., and for a new such station at Opa-Locka, near Miami, Fla., the latter to cost about $5,000,000 of the amount noted. At this last mentioned base, a new power house is estimated to cost $150,000; gasoline storage plant and pumping station, $100,000; water supply and distribution system, $300,000; and cold storage plant, with mechanical laundry, $100,000. At Jacksonville, present power house will be enlarged and additional equipment installed, to cost about $100,000; a new gasoline storage and distributing system will be required, at estimated cost of $220,000 Other work scheduled includes, steam distributing system, $75,000; compressed air system, $65,000; and shop and hangar, $350,000. At the Charleston, S. C., navy yard, program will include, expansion and improvements in power plant, with installation of additional equipment, $400,000; new motor-generator set and accessory equipment for shipways, $100,000; weighing and mechanical-handling equipment, including transportation facilities, $100,000.

Detroit Edison Company Expending $12,000,000 for Plant Expansion

THE DETROIT EDISON CO., Detroit, Mich., has begun work on an extensive expansion and improvement program in generating plants and system, to represent a total investment of close to $12,000,000. Project will include extensions and modernization at Delray power station, where a new 75,000-kw. turbine-generator unit and auxiliary equipment will be installed in power plant No. 3. This will duplicate a generator of similar capacity placed in service December 1938, giving a rating of 150,000-kw. for the two main machines. Extensions will be carried out in other sections of the plant, including switchyard and transmission lines. This will make the 25th. turbine-generator unit in operation at the four steam-electric stations of the company, with a gross output of 1,085,000-kw. The Delray development also will include a new office building and restaurant, on which construction has started, to replace a structure erected in 1910, when power house No. 1 was built, now long since retired from service.

Improvements are under way at the Conners Creek power plant, where equipment for stack gas control is being installed on one of the main boiler units; the apparatus is designed for the removal of cinders from stack gases and will be of experimental character, the entire station to be so equipped if the results are satisfactory. At Trenton Channel power plant, a new coal dock will be built to handle fuel arriving by water route, to include complete mechanical-handling facilities. A number of new power substations will be built in different districts before the close of 1940, with extensions in primary and secondary lines, including lines in rural areas.

Large Power House at Powder Mill

THE TENNESSEE POWDER CO., Knoxville, Tenn., care of J. M. Burnett, Jr., Hamilton Bank Building, Knoxville, attorney and representative, recently organized, has plans in progress for the construction of a large plant for the production of smokeless powder on tract of about 5000 acres of land in vicinity of Memphis, Tenn. A steam-electric generating plant is planned to provide service for the entire development, which will comprise a group of close to 100 buildings for different departments of operation. Similarly, an extensive deep-well pumping station will be installed to provide daily output of 22,000,000 gals. of water, estimated as plant requirements in a 24-hr. period. Other mechanical building also will be built for plant service. The new works will be equipped for a capacity of about 50,000,000 lbs. of packed smokeless powder per annum, and is reported to cost close to $15,000,000. Plant will be designed, erected and operated under the direction of E. I. duPont deNemours & Co., duPont Building, Wilmington, Del. It is said that the British Purchasing Commission, office of British Consulate, 25 Broadway, New York, N. Y., will be active in the financing and development of the project.

Obituaries

John W. Irvine

JOHN W. IRVINE, 63, superintendent of Pittsburgh Piping & Equipment Co., died May 25 at his home in Pittsburgh of a heart attack. He was one of the original employees of the company when it was founded 37 yr. ago and for the last 15 yr. has been superintendent.

George L. C. Bourne

GEORGE L. C. BOURNE, Chairman of the Board of the Superheater Co. and of Combustion Engineering Co., Inc., died on May 25 at the age of 67. He was born in London, although his parents had previously resided in the United States. He had many years of experience on the Hudson Bay Co. and Canadian Pacific Railroad, Chicago, Rock Island & Pacific Railway and the Chicago and Great Western Railroad. His railroad background led to his association with Samuel G. Allen and the late Joel S. Coffin in the founding of the Superheater Company, manufacturing special locomotive equipment. At first he was vice president and in 1915 became president of the company, which position he held until he became Chairman of the Board. In 1933 he was made Chairman of the Board of Combustion Engineering Co., Inc., which at that time became affiliated with the Superheater Co. Surviving are his wife, two daughters and one son.

W. F. Fischer

W. F. FISCHER, well-known for many years in the consulting and contracting power plant field, died at his home in Woodhaven, N. Y., on April 16. Mr. Fischer spent practically his entire lifetime working in power plant design, operation or construction. He retired about 2 yr. ago. At one time or another he was connected with the following concerns: M. W. Kellogg & Co. as chief draftsman; New York Edison Co. in the engineering department; New York Steam Co. in the engineering department; the J. G. White Engineering Corp. as assistant to the chief mechanical engineer; W. Beckers Aniline and Chemical Co. as chief engineer; Combustion Engineering Co. on boiler and plant design, and for a number of years conducted a private practice as consulting engineer and contractor on power plants and heating and ventilating work in general.

Announcing--

SILICA REMOVAL

New Allis-Chalmers Treatment

1 **No Additional Equipment Necessary.**

2 **Low Treatment Cost per Thousand Gallons.**

3 **No Increase in Total Solids.**

4 **Complete Service by Allis-Chalmers Feedwater Treating Department.**

SILICA elimination from boiler feedwater is at last an accomplished fact!

That's the news announced this month, after long research, by Allis-Chalmers feedwater engineers. It's important news to industry . . . for in this new method, silica is removed externally in conjunction with the usual lime-soda softening process. No expensive equipment is needed. And initial silica concentrations as high as 35 ppm have been reduced to below 2 ppm in the treated water!

As every power plant man knows, previous attempts to remove silica externally have required a major investment in equipment and a prohibitively high operating cost for treatment. In addition, only partial removal has been effected while total solids increased in the treated water to cause carryover from the boilers.

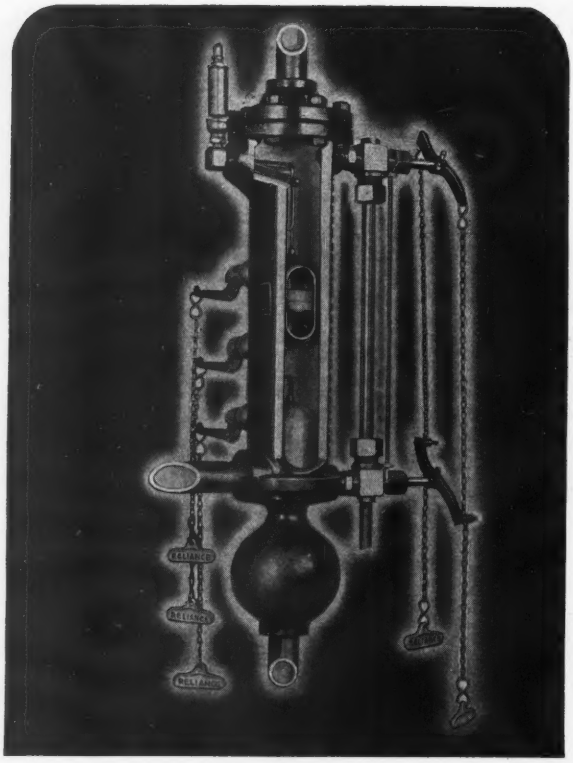
That's why, if you are operating high pressure boilers in your plant, the elimination of silica is important news for you. It will pay you to get the story of this new, proved way to solve your silica problems for little cost . . . without capital expenditure . . . with no increase in total solids.

A request on your letterhead will bring full details. Write — Feedwater Division, Allis-Chalmers, Milwaukee, Wisconsin.

A-1247

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN



Avoid the risk of costly shut-downs with dependable

Reliance

WATER LEVEL ALARMS

Thousands of engineers insist on having Reliance Alarms on their boilers—men who can boast of outstanding power plant operation, without time lost in shut-downs, and without fear of damage from water level accidents. The Alarm's sensitive mechanism responds instantly to dangerously low or high water levels—warns boiler-room men by shrill whistle or electric signal. Sturdily built to take the punishment of operating conditions.

The busier you are the more it pays you to *keep* power flowing, and protect your reputation for efficient low-cost power plant operation. Write today for full information on the Alarm.

The Reliance Gauge Column Company
5902 Carnegie Avenue Cleveland, Ohio

Reliance
Boiler Safety Devices since 1884

A.S.M.E. Semi-Annual Meeting at Milwaukee

THIS YEAR the American Society of Mechanical Engineers conducted its Semi-Annual Meeting in three different cities on dates that overlapped. Milwaukee, Wis., was the scene of the Society's business and committee meetings, and sessions devoted to hydraulics, power, education and training, management, fuels, railroads and machine shop practice. These activities were interspersed with plant trips and social gatherings during the four days including June 17 and 20. At Ann Arbor, Mich., the applied mechanics technical division held its meeting on June 20 and 21, while the oil and gas power division chose Asbury Park, N. J., for its meeting place, where sessions were held on June 19, 20, 21 and 22.

Pledge to Support Defense Program

One of the first items of business at the Milwaukee meeting was the passing of a resolution pledging the cooperation of the Society with the U. S. government in its defense program. The resolution makes available to army and navy authorities a list containing the various qualifications of its membership.

As has become customary with the Society, the nominating committee made its recommendations of officers for the next year at this meeting. The election will be by letter ballots which will be completed during September. Those nominated are:

For president: William A. Hanley, in charge of engineering at Eli Lilly & Co., Indianapolis, Ind.; for vice-presidents: Dean Samuel B. Earle, Clemson College, Clemson, S. C.; Frank H. Prouty, consulting engineer, Denver, Colo.; and Edwin B. Ricketts, mechanical engineer of Consolidated Edison Co. of New York, New York, N. Y.; for managers: Professor Hubert O. Croft, head of Mechanical Engineering Dept., State University of Iowa, Iowa City, Iowa; Professor Paul B. Eaton, Lafayette College, Easton, Pa.; and George E. Hulse, chief engineer, Safety Car Heating & Lighting Co., New Haven, Conn.

Plant Trips

Among the scheduled events were five plant visitation trips arranged by the executive committee in charge of the meeting headed by Fred H. Dorner, general chairman, Hans Dahlstrand and Wm. D. Bliss, vice-chairmen, and Bruno V. E. Nordberg, chairman of the Milwaukee section, as honorary chairman.

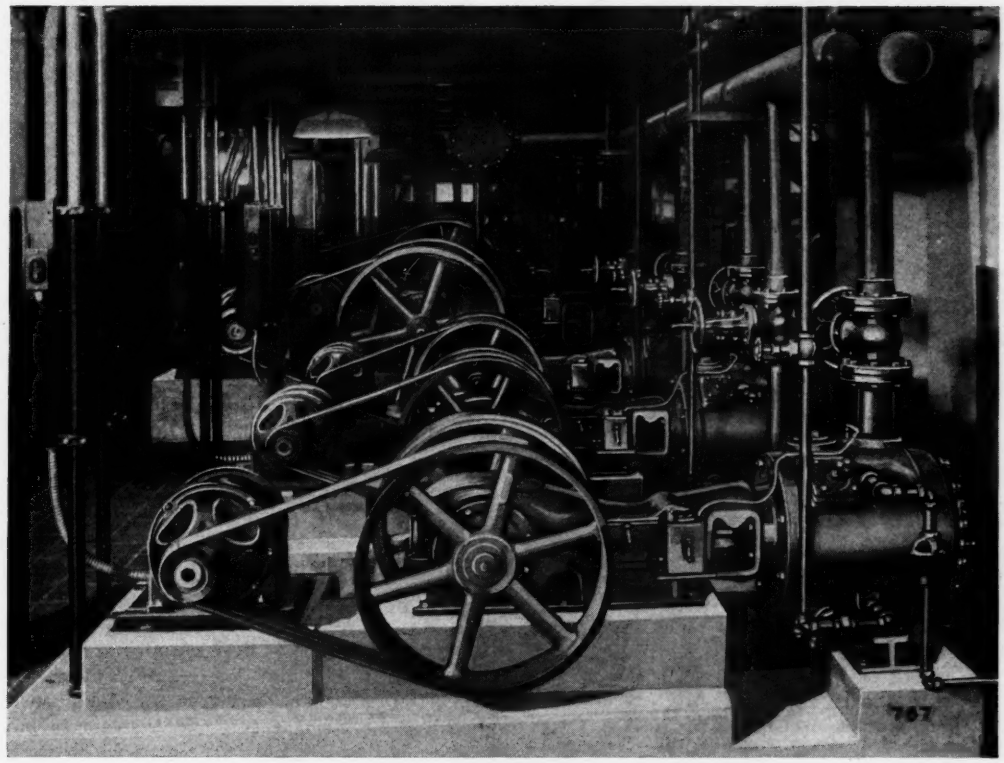
Trip 1 was to the Port Washington plant of the Wisconsin Electric Power Co., which holds an enviable reputation for reliability and economy.

Trip 2 took visitors through the plant of the Nordberg Mfg. Co. where several large-size Diesel engines were in process of erection and testing.

Trip 3 provided visitors an opportunity to witness the manufacturing methods of the Allis-Chalmers Mfg. Co. at its West Allis plant. Here some 400 engineers were conducted through the plant and witnessed the making of machinery from foundry to the testing floor.

Continued on Page 118

GENEROUS RECOGNITION OF FINE QUALITY



Partial view of PENNSYLVANIA vacuum pump and air compressor units installed in plant of Industrial Rayon Company at Painesville, Ohio.

AIR CUSHION VALVE

The recognized superiority of this valve is largely due to its marked simplicity. Without bolt or screw in entire assembly (guard and seat are held together by a retainer ring of spring wire) there is nothing to jar loose and fall into cylinder, and no screws or nuts to "burn" fast. Disc and springs are of non-corrosive, stainless steel. Method of mounting prevents warping or distortion of valve seats.

The foregoing illustration depicts one of the many installations of PENNSYLVANIA reciprocating dry vacuum pumps and air compressors which are efficiently serving prominent industrial plants throughout the country.

No other feature has contributed more importantly to the outstanding performance of this fine equipment than the PENNSYLVANIA Air Cushion Valve, which for light, quick action, tight-seating and durability is unequalled for vacuum pump and compressor service.

Every other feature embodied in the design of this equipment is of the same high standard as the valves, including totally enclosed, oil-tight, dirt proof construction; Timken heavy duty roller main bearings; one-piece forged steel connecting rod with solid ends; solid hub wheels mounted on shaft with taper fit; automatic lubrication throughout; enclosed mechanism for driving force-feed lubricator, etc.

Send for Bulletin 184

PENNSYLVANIA PUMP AND COMPRESSOR CO.

Main Office and Works, Easton, Pa.

AIR COMPRESSORS • VACUUM PUMPS • CENTRIFUGAL PUMPS • AIR LIFT PUMPS

ONE DART
PROVES IT

YOU CAN'T LOSE on this deal . . . for we give you the one Dart that proves it. Proves what? That Dart's tight ball-joint . . . made up of two spherically ground bronze seats . . . has more service-lives than the indestructible cat. Easy to make up and take down, time and again. And every time the seat is tight . . . every time, your savings increase. Prove this on your own lines. Send for your free trial Dart today.

DART
UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.
Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Machine tool designers were interested in Trip 4 to the Kearney & Trecher Corp. plant which is reputed to be the largest plant in the world devoted exclusively to the manufacture of milling machines. The Pabst Brewing Co. was the host on Trip 5.

Power Sessions

At the power sessions of the meeting predominance of attention was given to the details of steam turbine design and materials. R. C. Allen of Allis-Chalmers Mfg. Co. lead the first session with a paper on steam turbine blading in which he indicated some of the mechanical aspects of blading construction that have been developed in the past few years to meet the demands for high capacity, high speed machines, designed for maximum pressures and temperatures.

As a result of his analysis of the application of principles of harmonic vibration to motion of partial admission impulse blades, H. D. Emmert, also of Allis-Chalmers Mfg. Co., comes to the conclusion that there are three unrelated frequencies which influence the motion of a turbine blade under a dynamic loading cycle. The first is the rotational frequency of the turbine spindle, the second the natural running frequency of the blade, and the third the frequency of variation of the force field before the nozzle groups.

After presenting data gathered from the field to show the progress in design and performance of modern large steam turbines for generator drive, G. B. Warren of General Electric Co. concluded his paper with the statement that "The steam turbine power plant is the most efficient means which we now have commercially available for transforming the energy of our great solid fuel resources into the power which plays such an important part in the lives of us all."

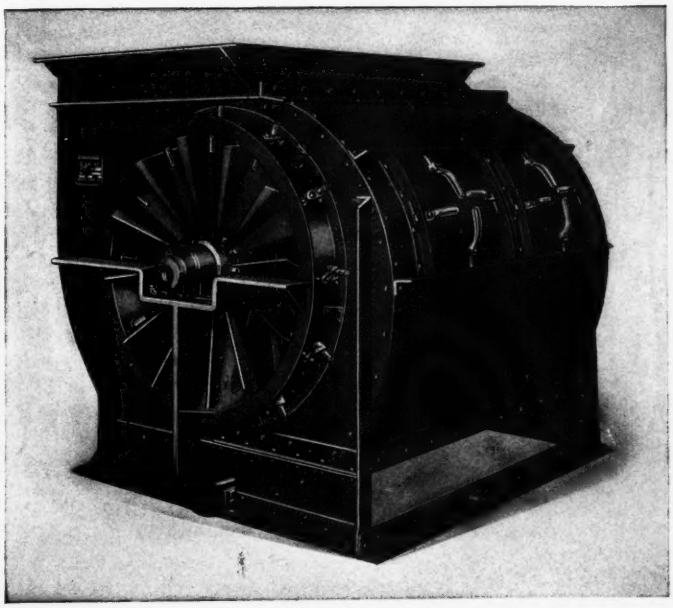
The character of the forces acting on turbine blades is much more complicated than is at first apparent, stated R. P. Kroon of Westinghouse Electric & Mfg. Co. in discussing the methods he has used in the fatigue testing of turbine blades. There are the obvious steady stresses due to centrifugal force, driving torque, and pressure drop and, occasionally, there are stresses due to differences in temperature of the parts. He considers, however, the vibratory stresses to which blades are subjected, by far the most important.

One of the most helpful papers presented dealt with the relative engine efficiencies realizable from large modern steam-turbine-generator units and was prepared by G. B. Warren and P. H. Knowlton, both of the General Electric Co. The authors analyzed the results of tests on more than 100 turbines under station operating conditions and pointed to the progress in turbine efficiency made over the last 20 yr.

In a survey of heat-insulation problems in steam plants, E. T. Cope and W. F. Kinney, both associated with the Detroit Edison Co., discussed several important problems such as the trend in labor costs, insulation of furnace walls, ducts and fan housing, piping and accessories, and steam turbines. Some definite recommendations were made and a few general conclusions reached. Their studies have brought the

Continued on Page 120

Check the Performance—



Buffalo Type "SLD" Forced Draft Fan with Variable Inlet Vanes.

The manufacturer's performance curves are only ONE check on the performance of a fan. The REAL check-up is made on the job—where continuous operation under adverse conditions brings out the inherent weaknesses as well as the good points.

Users of Buffalo Forced and Induced Draft Fans find that they stand up well under the most severe service—they PERFORM on the job.

Design is important—

In the selection of power plant fans, remember that design is important, because the sturdiest construction will not make up, on the job, for poor design. But remember also—

Construction is important—

That's why we put so much emphasis on heavy duty construction of all parts of Buffalo Power Plant Fans. WE know from many years' experience with hundreds of installations, that Buffalo Design is satisfactory. YOU can satisfy yourself easily that Buffalo CONSTRUCTION is unexcelled. Why not have Buffalo Fans in your power plant?

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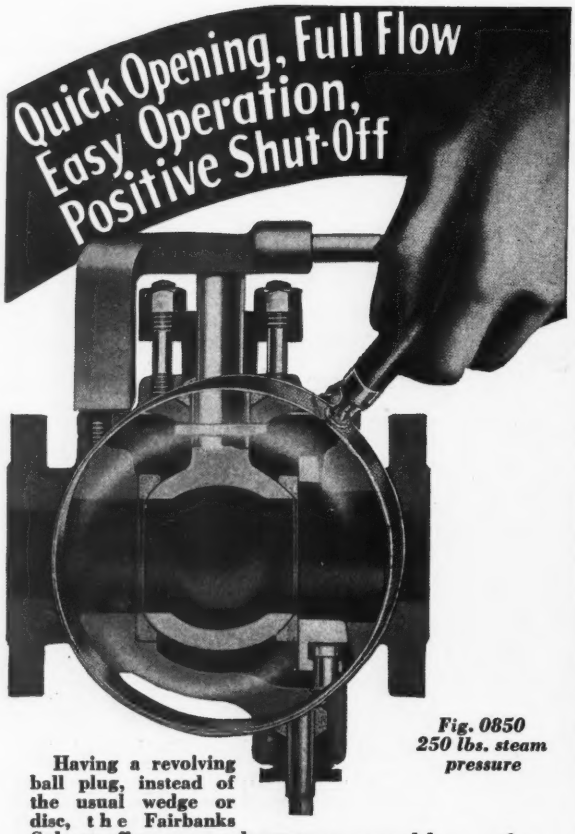

Fig. 0850
250 lbs. steam pressure

Having a revolving ball plug, instead of the usual wedge or disc, the Fairbanks Sphero offers many advantages possessed by no other valve.

It positively eliminates frictional resistance to stream flow, as the round opening in ball plug is the same size as that in the pipe. When the ball plug is opened or closed, it wipes seating surfaces clean. Its shearing action cuts through heavy solids and liquids that would cause ordinary valves to stick and jam. There is nothing on which scale or foreign matter can accumulate.

A positive shut-off is assured as the seat rings form a perfect fit with the ball. A wedge permits adjustment to make the seat rings absolutely pressure tight. And wear on seat rings is reduced to a minimum by the rotary movement of the ball.

A quarter turn of the lever handle opens or closes the valve "as quick as a wink". And you can always be certain that it is fully open or shut tight because it has a positive stop.

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Fairbanks Sphero Valves

authors to the conclusion that users of thermal insulation should be willing to spend more for materials that will be conducive to lower cost of installation and, at the same time, will render better service by alleviating some of the difficulties now experienced with performance and maintenance.

In so far as suitable alloys for pipes and bolts for high temperatures are concerned, the art is yet in its development stage. A. E. White and C. L. Clark, both of the University of Michigan, drew that conclusion from their experiences with metals at high temperatures for power plants. In this field, carbon-molybdenum steel is receiving the greatest amount of attention and so the properties, control of grain size, heat-treating practice, creep rates, and kindred matters for this material were dealt with in their paper.

Air Pollution and Combustion Technique

Fuels came in for their fair share of study at the meeting with six papers taking up specific topics. Osborn Monnett described the air polution study which has been conducted in the city of Chicago. This survey covered fields in which little or no information was on file. The topics discussed in his report included smoke reading, atmospheric dust and noxious gases in the air and at the source, sunshine and ultraviolet ray analysis, literature and legal aspects. L. C. Whiton, Jr., of Prat-Daniel Corp. discussed the problem of determining the comparative efficiencies of individual cyclone-type dust collectors and cyclones grouped with interconnecting ducts and hoppers. At this same session, H. C. Corroll of the Commercial Testing Equipment Co. outlined the trend in steam generation towards one-boiler unit operation and covered the advent of water-cooled stokers and their advantages as compared to water-cooling of refractories.

In another session devoted to power and fuels, R. H. Sherlock and E. A. Stalker, both of the University of Michigan, gave the results of their studies on the control of gases in the wake of smokestacks. F. L. Dornbrook of the Wisconsin Elec. Pr. Co. described the development of a major principle in pulverized coal firing which has resulted in what is said to be a practically self-cleaning, reliable, efficient furnace capable of operating continuously month after month under variable conditions of coal, load, and attendance. Twenty years ago, the use of pulverized coal for steam generating purposes was started in Milwaukee and Henry Kreisinger of Combustion Engineering Co. and John Blizard of Foster Wheeler Corp. were intimately associated with the late John Anderson in this pioneering work. Their paper presented at this meeting on Milwaukee's contribution to the art told of many entirely new problems which were confronted and how most of these were solved then and through the intervening years.

At the hydraulic sessions the papers presented were as follows: Turbulence and Energy Dissipation, by A. A. Kalinske of the State University of Iowa; A Theory of Cavitation Flow in Centrifugal Pump Impellers, by Calvin A. Gongwer, Jr., of the General Motors Corp.; Centrifugal Pump Efficiency Measurements—An Improved Technique, by R. W. Angus of the University of Toronto; and Economic Draft Tube Proportions, by A. R. Dawson of the University of Toronto.

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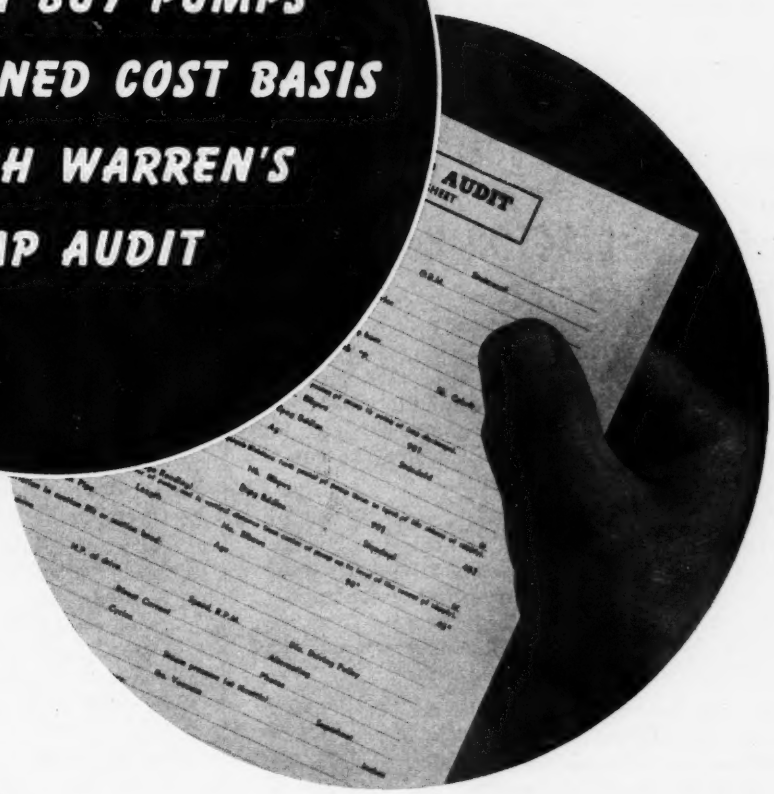

A NEW service to pump users, Warren's Pump Audit is a clean-cut, down-to-earth method designed to (1) put your pumping costs on record (2) permit a thorough check for excessive power consumption or maintenance charges (3) reduce pump operating costs through improved efficiencies . . . The Pump Audit, a fact finding job being made by Warren engineers in many plants, gives you the facts you need to install pumps on a *planned cost* basis: pumps that will keep operating costs down, and efficiencies up, year after year . . . First step in the Pump Audit is the "P. A. Data Sheet" a convenient form for getting basic facts on your pumps. We invite you to send for a copy of the P. A. Data Sheet, and further facts on how the "Audit" can save money in your plant. There is no obligation.

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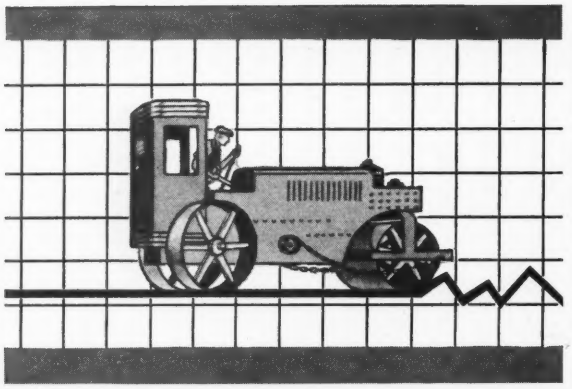

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FOR more than five years—on thousands of machines—the quick-action, wide-range rheostatic element of G-E Diactor generator regulators has been giving voltage regulation that is really *smooth*. It provides an almost infinite number of smooth resistance steps from practically zero to the maximum, resulting in a regulation curve that is correspondingly smooth.

Here's how the Diactor regulator helps you to maintain constant voltage. It holds the voltage close to the desired value without hunting or instability. After a change in operating conditions, it quickly returns the voltage to normal. Because of its simple, reliable design, you are not troubled with bothersome, costly maintenance.

Whether your voltage-regulation problem involves a new installation, replacement of old regulating equipment, or providing adequate regulation for machines already in service, you will find a Diactor regulator fitted to your needs.

A specialist in the nearest G-E office can give you detailed information. Or write for bulletin GEA-2022. General Electric Co., Schenectady, N. Y.

GENERAL ELECTRIC

Elevator Safety Code

THE American Standard Safety Code for Elevators, Dumbwaiters and Escalators, which was developed under the sponsorship of The American Society of Mechanical Engineers, American Institute of Architects, and the National Bureau of Standards under the procedure of the American Standards Association, has formed the bases for laws enacted in many states and cities throughout the country. From time to time new regulations and ordinances covering elevators are being adopted or old ones extensively revised. Since most of these regulations are modifications or adaptations of the rules making up the American Standard Code, it is important that this code be at all times as accurate and as up-to-date as possible. Since the publication of the fourth edition (1937) attention has been called to certain rules which seem to require clarification. Further, the advancement of the art has made necessary the revisions of certain of the rules and the addition of new material. Sectional Committee A17, organized under the procedure of the American Standards Association, with the assistance of its Subcommittee on Research, Recommendations and Interpretations, has conducted considerable research and is now planning to issue a small pamphlet which will contain the clarifications of obscure passages, the revised rules and new material in convenient form for the users of the American Standard Code.

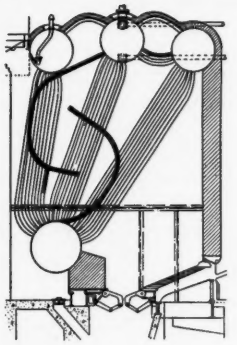
While the Subcommittee is constantly receiving criticisms and comments it is probable that its files do not now contain copies of all of the criticisms and comments which have been made on the present edition of the code. Accordingly, all persons connected with the manufacture, installation, and use of elevators, both passengers and freight, are urged to send their comments to the Secretary of the Subcommittee, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

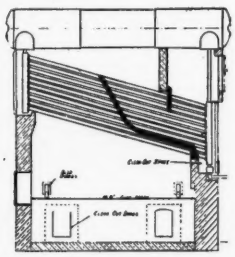
Training of Industrial Employees

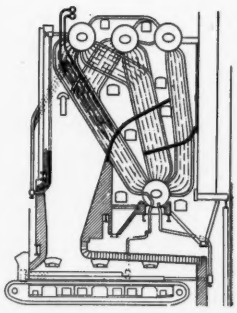
IN STEPPING up production to handle unusual demands from certain domestic and foreign markets, a number of industries today are faced with a serious shortage of skilled labor. To meet this situation management must find some way to train men quickly. Experience from the last World War period showed that short-cuts in training are incompatible with production efficiency and product integrity. As then, management today believes that the only satisfactory answer is to refine or streamline the training methods, cut all waste and lost motion, and in general step up the tempo without

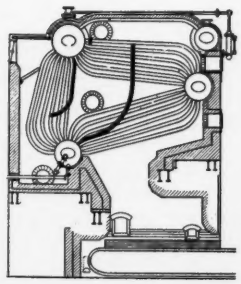
Continued on Page 124

Enco Streamline Baffles

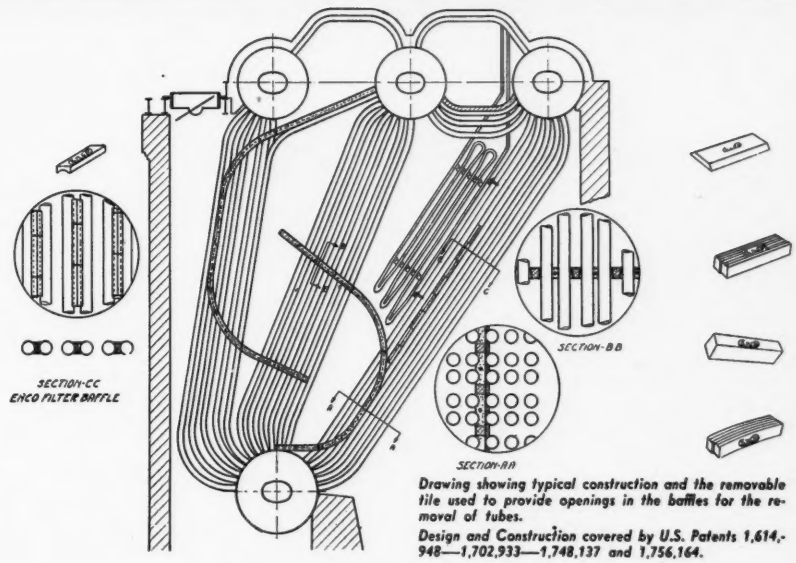








ENCO Streamline Baffle Design



Drawing showing typical construction and the removable tile used to provide openings in the baffles for the removal of tubes.

Design and Construction covered by U.S. Patents 1,614,948—1,702,933—1,748,137 and 1,756,164.

ENCO Cross Baffle Construction

Improve performance • increase capacity

The performance of new and existing water tube boilers can be improved to obtain Increased Capacity and Better Operating Efficiency with ENCO BAFFLE WALLS. Because they are—

DESIGNED for better heat distribution to insure lower flue gas temperatures and higher efficiencies.

STREAMLINED AND CURVED so that a wide flexibility in design is possible to suit various tube and superheater arrangements. The entire heating surface is covered more effectively and the greatest rate of heat transfer obtained. THE SMOOTHLY CURVED SURFACES of the streamlined baffles ELIMINATE ANGLE JOINTS and avoid eddy currents and dead gas pockets and thereby decrease the draft loss through the boiler. These surfaces also permit soot blowers to work more effectively and keep the boiler clean for a longer period.

CONSTRUCTED GAS TIGHT by experienced mechanics who are specialists and who install the baffle wall true to design with uniform thickness and with smooth finish surfaces. Tile, Plastic and Rod construction permits tube renewal with minimum damage and easy repair to Baffle Walls.

ENCO BAFFLE WALL TILE AND PLASTIC MATERIALS are selected from the best refractories obtainable, specially processed for baffle wall construction and will withstand high temperatures for many years of continued service.

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The new double-bridge, self-aligned assembly used on these WARE HI-LAG Fuses is easy to renew and insures extra strength and longer life. Assembly may be inserted either end first.

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sacrificing the essentials of good training. The details of how industry is doing this are given in a new report. Intensive Training of Industrial Employees, issued by the Policyholders Service Bureau of the Metropolitan Life Insurance Co.

The report points out that some of the initial steps to be taken in meeting this problem include accurate determination of a company's labor requirements, careful analysis of the employee's qualifications coupled with proper placement, and better organization of labor sources. Reorganization of the skilled man's job, separating the less skilled phases of the work for which new men can be more quickly trained, has proved effective in speeding up the training. Another approach is to improve the quality of the training by carefully meshing the essential training material with a detailed analysis of the production job. Indvidualizing the training as much as possible so as to give each employee the minimum instruction needed has been found much less wasteful than a program based on average ability.

These are but a few of the devices that industry is employing to meet the emergency problem of training for skilled jobs as disclosed in the Metropolitan's study.

Boulder's Expanding Service

SUMMING up 3 yr. of power operations at the Boulder Dam power plant, Commissioner Page has advised in a recent report that the gross income was about $2,000,000 ahead of that anticipated when financial plans for the projects were first drawn up.

Income for the present fiscal year is expected to exceed $4,500,000, bringing power plant revenues received from July 1, 1937 to June 30, 1940, under Boulder's 50-yr. power contracts, to approximately $11,300,000. Gross income from the plant has shown steady increase as generators have been installed one after the other to meet the unexpected demand for energy.

During 1936-37, with four generators in operation, the first of which went into action October 22, 1936, Boulder income under temporary interim contracts (which disposed of power at secondary rates) totaled $247,723. The following fiscal year, 1937-38—the first under regular 50-yr. contracts for firm power—the gross income rose to $2,945,230. The next, 1938-39, it rose to $3,835,690. During the present fiscal year 1939-40, receipts have totaled $3,693,757 to the end of March, with three months to go.

With only nine of Boulder's capacity 17 generators installed, gross income has been averaging over $350,000 a month or well over $4,000,000 annually. The cost of Boulder Dam, reservoir and power plant as of June 30, 1939, exclusive of interest, was $116,128,135. The Bureau of Reclamation is about to order another generator for installation at the power

Continued on Page 126

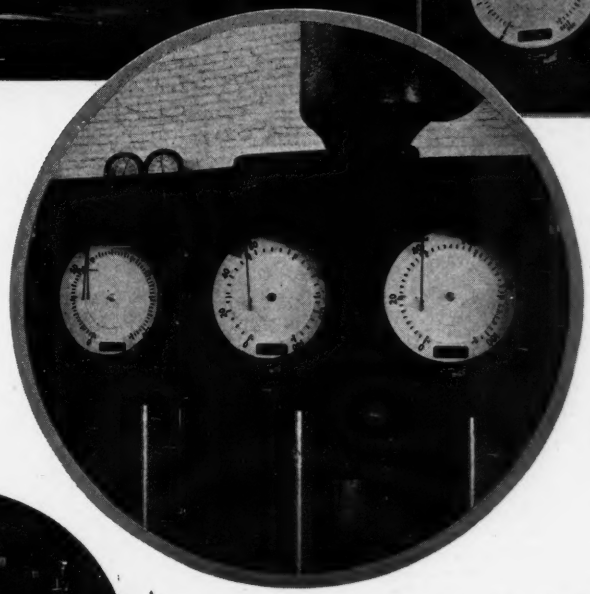
24 Cochrane Meters at Alton Box Board Co.

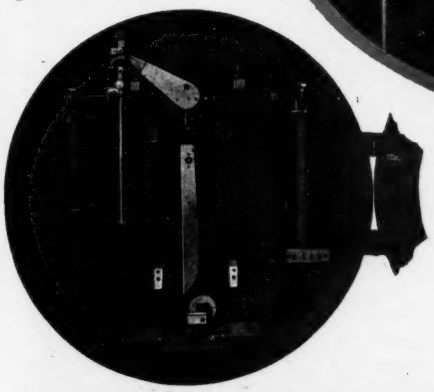
. . . FROM AN INITIAL PURCHASE OF FOUR COCHRANE MECHANICAL FLOW METERS IN 1929 . . . ALTON NOW HAS TWENTY-FOUR

Upper Right: Boiler control panel with steam and feedwater flow meters, each recording temperature and pressure in addition to flow.

Right: Panel for the 2500 kw. turbine generator with (left to right) meter recording throttle flow and pressure, bleeder flow meter and exhaust flow meter.

Below: Interior of flow meter case showing simplicity of design and construction. Note U-tube, balance and torsion tubes.





FOR the past 11 years the Alton Box Board Co. of Alton, Ill. has been constantly adding to their original installation of four Cochrane Mechanical Flow Meters.

Five record steam flow and five more record the fuel supply to each of the gas-fired boilers. In addition, feedwater flow meters are used with two of the five high pressure boilers. Additional flow meters are used to record pressure and flow at throttle, flow of bleed steam and exhaust steam of the 2500 kw. and 1500 kw. turbines; steam flow between the reducing valve stations; water flow of the condenser circulating water and the bleeder flow of steam to the paper machines.

All the meters are the indicating, recording and integrating type and many are equipped with temperature and pressure elements.

Our illustrated Publication No. 2094 describes the many applications for which mechanical flow meters are designed. Publication 2096 describes Cochrane Electric Flow Meters. Either or both publications will be mailed on request.

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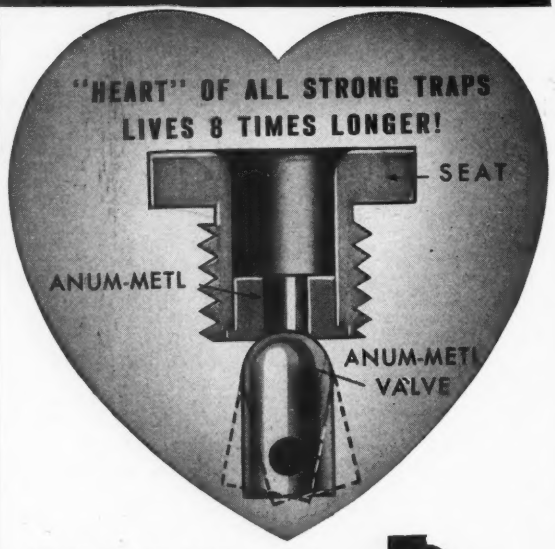
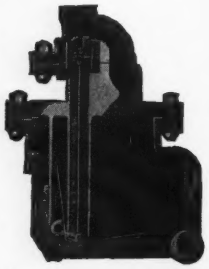
"HEART" OF ALL STRONG TRAPS LIVES 8 TIMES LONGER!



STEAM LEAKS COST MONEY!

Diam. of leak	Lbs. steam wasted per 100 lb. press	Cost per mo. at 50c per M lbs.
¼"	203,000	$101.50
1/8"	50,500	25.25
1/16"	12,750	6.38
1/32"	3,175	1.58



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Try the correct Strong traps for 3 months. Then agree they are your best buy *regardless of price,* or return them and get your money back, *plus freight!*

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STRONG
STEAM TRAPS

plant, bringing the total to 10. The original schedule for the installation of power at Boulder, mapped out in 1930, called for only seven generating units in operation by the end of this fiscal year.

Throughout the entire period of the installation of power at Boulder the demand for energy has required the operation of generating units as quickly as possible to meet the needs of power contractors. The unexpected demand began as soon as the dam was completed in 1935, and pressure was put on the Bureau's construction forces to place the first unit in action at the earliest possible date.

Power generation at Boulder by calendar year has shown the effects of the growing demand for energy. In 1936, the plant generated 123,993,000 kw-hr.; in 1937, 1,180,143,000 kw-hr.; in 1938, 1,522,627,000 kw-hr., and 1939, 2,507,932,000 kw-hr.

Boulder now has 10 high-tension transmission lines extending from its power plant to customers. Two lines extend to Los Angeles 266 mi. away. Another line goes to Chino, California, 233 mi. off. A third goes to San Bernardino, California, 222 mi. distant. Other lines go to Hayfield, California, Parker, Arizona, Kingman, Arizona, Needles, California, Pioche, Nevada, and Las Vegas, Nevada, and, of course, Boulder City.

Stoker Manufacturers Are Optimistic

AT THE 23rd annual meeting of the Stoker Manufacturers Association held during the first week in June, at Hot Springs, Va. Officers and members of the Association expressed a new note of confidence in the ability of the stoker industry to continue its progressive merchandising and advertising programs in the face of unsettled world conditions and they backed this up by pointing to the increase in sales of stokers for the first four months.

The two-day meeting devoted its attention largely to merchandising and sales programs and problems. The progress made within the past year in engineering and development work, however, came in for particular study because of the increasing public interest in home building and construction.

E. C. Sammons of Portland, Ore., who had served as president for two years, reported to the convention that the Association had endeavored to study and handle those problems which were of immediate concern to the manufacturers and that definite progress had been made in the past year. He spoke on behalf of the stoker industry in offering the services of the manufacturers, engineers and technicians, to the nation and the National Government in the preparations for national defense. Mr. Sammons reported that the Association had completed its standardization work on minimum setting heights and stoker ratings and that the Engineering Committee is undertaking studies on other phases of standardization that would be reported on at the winter meeting of the Association.

Continued on Page 128

Teeth Not Tension

NO POWER WASTE
NO SLIPPING

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- ★ LONG LIFE
- ★ COMPACTNESS
- ★ RUGGEDNESS
- ★ FLEXIBILITY
- ★ NO SLIPPING— "TEETH, NOT TENSION"
- ★ SAFETY PROTECTIVE HOUSINGS
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- ★ LOW FIRST COST
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MORSE *positive* DRIVES

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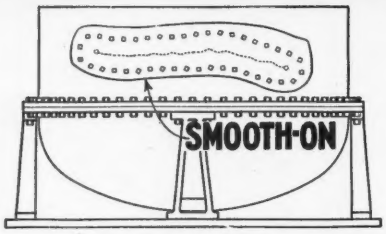
Emergency Repairs



quickly applied at low cost to plant equipment

Emergency and routine repairs to seal cracks and stop leaks in equipment under pressure, reinforce corrosion-weakened or punctured metal, and tighten loose parts, can be made by Smooth-On No. 1 with surprisingly little effort, time and cost.

This many-purpose iron cement is applied without heat or special tools, and forms a permanent seal which is proof against pressure and temperature variation, vibration, and the corrosive action of most chemicals.

The cost is negligible; and savings may amount to hundreds of dollars, because the use of Smooth-On frequently avoids replacement of expensive parts, disassembling and reassembling.

Buy Smooth-On in 7-oz., 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house or if necessary, from us. For your protection, insist on Smooth-On—used by engineers since 1895.

FREE

The Smooth-On Handbook—40 pages with 170 diagrams and concise, easily followed instructions for practical equipment repairs, based on the experiences of thousands of engineers. Send the coupon for your copy.

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STOPS LEAKS in SMOOTH-ON No. 1 CEMENTS IRON

for the Motor Car and Boat, Home, Factory and Power Plant

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Continuation of present sales trends would boost the stoker industry's 1940 production approximately 20 per cent above any previous year's total, according to Mr. Sammons. Making clear that unforeseen events can quickly void any estimates, he said that present operating schedules would produce about 125,000 stokers by the end of 1940. This compares with a 1939 total of 104,289 units.

Officers elected for the ensuing year were:

President, Frank Hoke, Indianapolis, Ind.; Vice-President, B. O. Fink, Auburn, Ind., and Treasurer, John Munro, Harvey, Ill. These three officers together with E. C. Sammons, of Portland, Ore., and C. E. Lewis, of Rochester, N. Y., comprise the new Executive Committee. Marc G. Bluth, Chicago, was re-appointed Secretary.

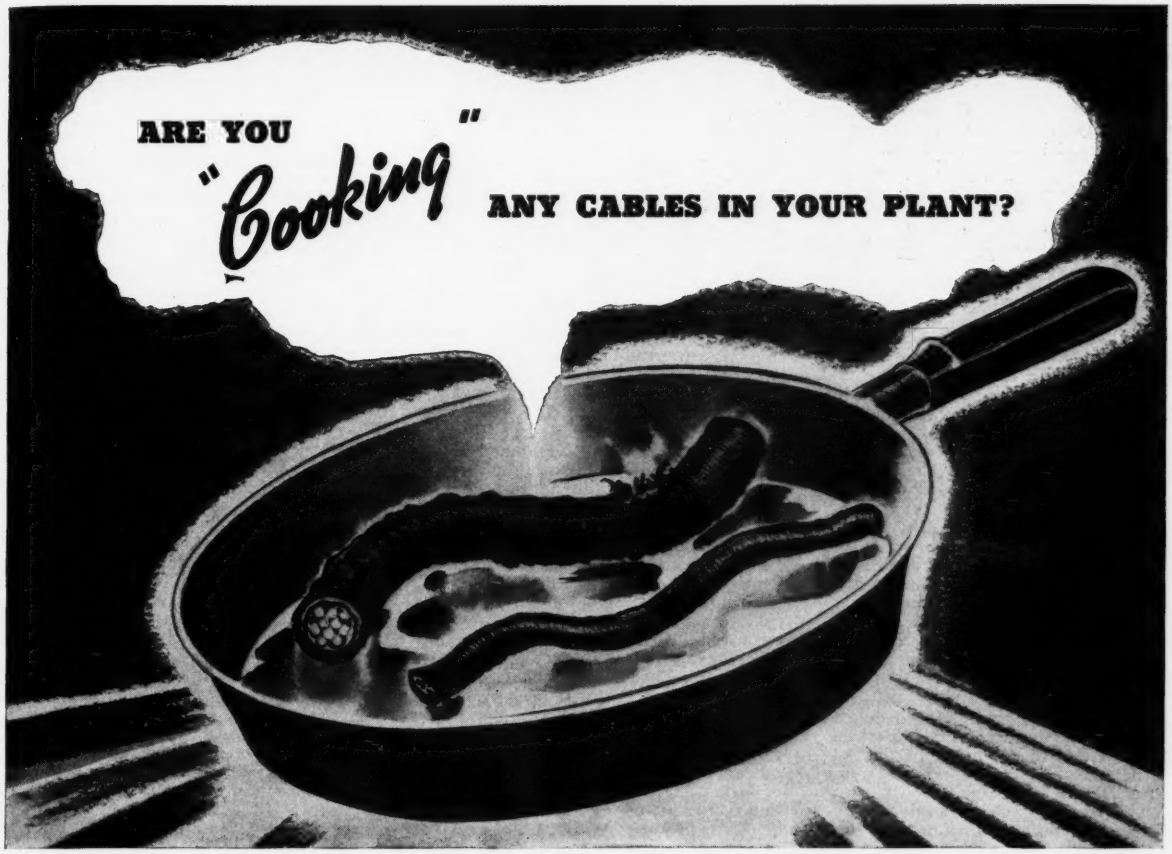
Stoker Adjustments

WALTER KNOX, director of the Koppers Stoker Coal Research Laboratory, Kearney, N. J., in an address at the Indiana Coal Merchants Association convention in Indianapolis, May 14 and 15, discussed factors involved in efficient stoker operation which can be applied by dealers in determining the reasonableness of possible complaints and whether the cause lies in the stoker or the coal.

"Cooking difficulties or packing of coal in the worm may be the result of improper adjustment or design of the coal-feeding mechanism. Under conditions producing excessive crushing or packing, which may cause heavier coking, the power consumption is also excessive. With correct operation the coal should move loosely through the coal tube, thus giving only moderate crushing (which is desirable to avoid 'smoke back') and requiring very little power to convey it. To achieve this, the point of greatest constriction of the coal should be at the entrance to the coal tube. Loosening of the coal after passing this point may be accomplished in various ways, such as increasing the pitch of the screw.

"When the spike trap is part of the entrance to the coal tube it should be lowered to correct packing or excessive crushing in the tube. Many service men have the mistaken idea that raising the spike trap lessens packing and crushing of coal. This is fundamentally wrong. You cannot force coal into the large end of a funnel and out the small end very successfully. Lowering of the spike trap, putting it down as close to the coal screw as possible without actually rubbing, is the correct procedure."

Mr. Knox discussed various designs of coal-conveying mechanisms pointing out the improvements that have been made. He described various mechanical features connected with proper air supply and distribution, also methods of controlling "smoke back." He stated that if a stoker smokes back it may be because air holes in the coal tube near the retort are plugged.



Are there some "hot spots" in your plant where rubber-covered cables are "cooking"? Think hard now—this is going on in hundreds of industrial plants today. Excessive heat is making rubber-covered cables brittle, cracking them, making electrical breakdowns an inevitable result.

These costly breakdowns usually occur in boiler rooms, foundries, ash pits, cranes, etc.—locations where the insulation of the rubber-covered cables cannot cope with the excessive heat.

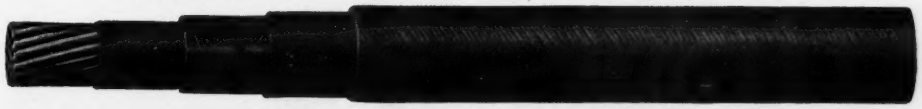
You can throw that frying pan right out the window of your plant, prevent costly electrical breakdowns caused by heat if you use Deltabeston Power Cables. Look at the heat ratings on these Deltabeston Cables:

DELTABESTON BOILER ROOM WIRE, YK3160

Insulated with felted asbestos, varnished cambric insert, and asbestos braid . . . Maximum copper temperature—110°C (230°F). For general conduit and boiler room wiring where temperatures are high.

DELTABESTON APPARATUS OR MOTOR LEAD CABLE, YK2251

Insulated with felted asbestos, varnished cambric insert, and asbestos braid—Maximum copper temperature—110°C (230°F). Great flexibility . . . Recommended for all low-voltage apparatus where operating temperature is high.



DELTABESTON POWER CABLE, YK2250

Insulated with felted asbestos, varnished cambric insert, and asbestos braid—Maximum copper temperature—110°C (230°F). For general power wiring where temperatures are high.

Send for a G-E Deltabeston Power Cable Catalog. Section Y-0857, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

New Engineering Books

A History of the Growth of the Steam Engine. By Robert H. Thurston. Centennial Edition, 555 pp., 5 by 7½ in., cloth. The Cornell University Press, Ithaca, N. Y. 1939. Price $3.00.

This new edition of this famous book was issued last fall when Cornell University celebrated the one hundredth anniversary of its author's birth on October 25th. It was appropriate that Cornell should honor Robert Thurston's memory in this way because he had been director of the Sibley College of Mechanical Engineering at Cornell from 1885 to 1903.

It seems to us that no man who calls himself a steam engineer should be without a copy of this book—at least he should read it. This book provides the background against which all the complex ramifications of present day steam practice can be projected. The historical background of the art of steam engineering is not only necessary to a full appreciation of its present high state of development but it also embodies many of the fundamental elements underlying our cultural development. No single invention ever affected the course of human progress more than did the invention of the steam engine.

Henry Ford is credited with the remark, "History is the bunk." Perhaps Mr. Ford said that, perhaps he did not, and whether he did or not does not matter; the fact remains that Mr. Ford has spent millions of dollars in the admirable pursuit of collecting and preserving original models of a wide variety of mechanical devices and this, to us, is evidence of a deep interest in "history." Robert Thurston did not have Mr. Ford's millions to establish historical museums but he had his interest in the historical aspects of his profession. He had the inspiration to collect everything that was known about the history of the steam engine and to assemble this material between the covers of a book for all posterity to read. From its first edition in 1878 this book met the need for such a work so well that it passed through six editions by 1907 and has remained, a classic, to the present day. The 1907 edition was the last edition until Cornell University issued this Centennial Edition last fall but in all the intervening years and despite the appearance of many books on the same subject by other authors, Thurston's work has remained unchallenged.

The steam engine deserves comprehensive historical treatment for as Thurston points out on the second page of his book, as religion has always been and still is the great *moral* agent in civilizing the world and as science is the great *intellectual* promoter of civilization (or the lack of it) so the steam engine is, in modern times, the most important *physical* agent in that great work. Our entire machine and power civilization rests upon the use of steam energy. The popular conception of the history of the steam engine begins with James Watt, but, of course, as everyone who has studied the subject even superficially knows, this conception is erroneous. As Thurston shows, Watt was the *greatest* inventor of the steam engine but still he was only one of many. Before Watt, countless others—those all the way back to Hero of Alexandria who described the first steam turbine—built the basic structure which Watt incorporated as part of his engine. The work of these early investigators has been recounted in many places but in Thurston's book it is all recorded in chronological order and in great detail. It makes fascinating reading and enables us better to appreciate the advantages at our disposal today. We who speak glibly of tolerances of the order of a ten-thousandth of an inch can appreciate the difficulties which even Watt had to contend with when we read how this pioneer congratulated himself upon the accuracy of his new cylinders which were only ⅛ *in. from true round!*

Electrical Meterman's Handbook. Fifth Edition. 8 by 10 in., 380 pages, 368 illustrations, 51 tables. Durable waterproof binding. Published by Edison Electric Institute, 420 Lexington Ave., New York City. 1940. Price $3.60 postpaid in U. S. A.

This new and completely revised edition of this well known handbook will be welcomed by everyone interested in electric meters. The last edition was published in 1923 by the National Electric Light Association. Since that time many developments have taken place in the meter art both in the design and construction of meters and in their applications and a new handbook to cover these developments was badly

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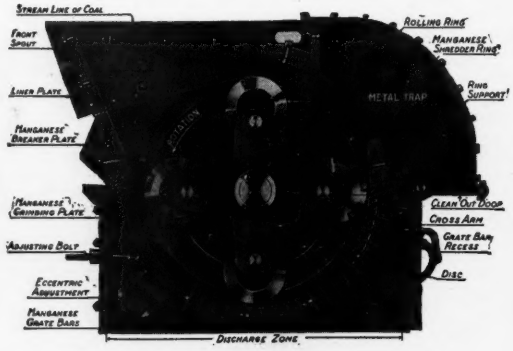
Better Coal Sizing Lower Steam Costs

American Ring Crushers reduce in one operation run-of-mine or lump coal to the proper sizes required for unit pulverizers and automatic stokers.

Reports from many users show that the better sizing assured by American Ring Crushers makes possible the use of a wider range of coals—improves combustion—effects fuel savings from 2½ to 8 per cent.

American Ring Crushers have capacities of 25 to 500 tons per hour, are built special for each installation and guaranteed for definite performance. Let American Crusher engineers cooperate in meeting your coal sizing needs.



Above: Cross-sectional view of American Ring Crusher. Right: Patent shredder rings split coal in uniform size instead of crushing it—a patented "American" feature.

AMERICAN PULVERIZER COMPANY
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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

needed. This new edition has been rewritten, condensed and brought up to date by meter authorities of leading utility companies serving on the Meters and Services Committee of the Edison Electric Institute.

Like the earlier editions, the new handbook has been designed to provide a practical tool for the meterman and the meter engineer confronted with the day-to-day problems of metering customer loads. It contains basic principles of metering, diagrams of connections principally used for all types of metering both for energy and for power, description of laboratory equipment and procedure, descriptions of all modern type meters and complete tables of constants for a c. and d.c. meters covering all types, both old and new, in current use. The theoretical material in earlier editions has been condensed, description of older types of meters and of direct current meters has been eliminated as being of limited usefulness today.

Design of Piping for Flexibility With Flex-Anal Charts. By E. A. Wert and S. Smith. Published by Blaw-Knox Co., Power Piping Division. Size 8½ by 11 in. Price $3.00.

Piping design for flexibility has always required considerable time and intricate calculation. With the increase in temperatures and pressures, the complexity of this problem has increased. After ten years' work on the part of the authors, this book was compiled to give the experienced designer a series of charts and simple formulae which would enable him to obtain the stresses, forces, moments and deflections in piping design of 1, 2 and 3 plane structures in a much reduced time.

The curves, tables and formulas given in this book can be used to determine the proper general design of the piping structure and will provide the piping design engineer with a simple method whereby rapid, accurate and complete flexibility analyses can be made for previously determined shapes. Although the price of this book is $3.00 it is available without charge to executives, engineers and others interested in piping design problems who request it on their business letterhead.

Machine Shop Training Course. By Franklin D. Jones. Published by The Industrial Press, 148 Lafayette St., New York City. Size 6 by 9 in., cloth bound. Vol. 1, 463 pp.; Vol. 2, 538 pp. Price, both volumes, $6; either volume purchased separately, $4.

Considering the importance of machine shop work in the production, maintenance and repair of machinery as well as in the production end of industry, this course should have a wide appeal to engineers for it not only tells how but why. Furthermore, it is written against a background of standardization so important in interchangeable manufacture and thus meets the need of the shop man, the student, the engineer who wants general information and the designer who must recognize available production methods.

The first volume covers the fundamental principles of metal-cutting operations, and continues with lathe work; tool forms and grinding; different screw thread standards and screw-thread cutting; turret lathes and automatic machines belonging to the lathe family; drilling, reaming, and boring; tolerances and allowances in interchangeable manufacture; and, finally, the various types of measuring and gaging tools, with typical applications.

The second volume deals with tapping, thread cutting with dies, planing practice; milling; gear-cutting; external and internal grinding; lapping, broaching, chipping, filing, and scraping; tool steels and the heat-treatment of tool steels.

Tests on the Liquefaction of Canadian Coals by Hydrogenation, by T. E. Warren and K. W. Bowles, is the title of a 106 pp. paper bound report issued as publication No. 798 by the Canadian Department of Mines and Resources. Copies can be obtained from the department at Ottawa, Ontario, for 25 cents. The report deals with the results of hydrogenation tests on a series of coals of varying range mostly of Canadian origin. A sample of coal processed in the commercial hydrogenation plant of the Imperial Chemical Industries at Billingham, England, has been included as a standard of comparison for the Canadian coals.

Standards of the Heat Exchange Institute, 90 West St., New York, covering deaerators and deaerating heater sections have been published as a 12-page, paper-bound booklet containing recommendations on nomenclature, definitions, construction, ratings, accessories and a typical specification. They are available at 75 cents a copy.

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Power Plant Construction News

Calif., Los Angeles—Harvill Aircraft Die-Casting Corporation, 2344 East Thirty-eighth Street, Vernon, plans installation of power equipment in new one-story plant, totaling about 50,000 sq. ft. of floor space, near Los Angeles municipal airport. Entire project reported to cost over $100,000. Austin Co., 777 East Washington Boulevard, will design structure and supervise erection.

Ill., Chicago—Sprague, Warner & Co., 600 West Erie Street, wholesale grocer, plans installation of electric power equipment in new one and two-story bulk storage and distributing plant at Sacramento and Franklin Boulevards. Also will install a cold storage plant, and conveying, loading and other mechanical-handling equipment. Entire project will cost about $1,700,000. A. Epstein, 2001 West Pershing Road, is engineer.

Ind., Evansville—Sunbeam Electric Mfg. Co., Read Street and Morgan Avenue, plans installation of electric power equipment in new two and three-story addition, 90x142 ft., addition to automobile headlight manufacturing plant. Cost reported close to $150,000. Edwin C. Berendes, 121 Upper Fourth Street, is architect.

Kan., Iola—City Council is considering extensions and improvements in municipal power plant, including installation of additional equipment. Survey has been made by E. T. Archer & Co., New England Building, Kansas City, Mo., consulting engineer, and report has been submitted. No estimate of cost announced.

Mich., Kalamazoo—American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y., manufacturer of industrial chemicals, plans installation of electric power equipment in new multi-story addition to branch plant at Kalamazoo. Entire project will cost over $100,000. Company is a subsidiary of American Cyanamid Co., same address.

Mich., Detroit—Chrysler Corporation, 341 Massachusetts Avenue, plans installation of power equipment in new one-story addition to Highland Park automobile plant, Oakland Avenue, 400x1000 ft. Entire project will cost over $850,000. Albert Kahn, Inc., New Center Building, is architect and engineer.

Minn., Maple Lake—Minnesota Rural Power Association, Maple Lake, will take bids in 30 to 60 days for new power plant for electric service for systems of several cooperative organizations in this district, consisting of a multi-story unit, about 60x150 ft., on site near Maple Lake, with installation to consist of three Diesel engine-generator units and accessory equipment. Entire project will cost close to $500,000. Financing has been arranged. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

Neb., Omaha—Cudahy Packing Co., 221 North La Salle Street, Chicago, Ill., plans installation of electric power equipment in new five-story addition to meat-processing and packing plant at Thirty-third and O Streets, Omaha. Cost over $125,000. Work will be placed under way soon.

N. J., Atlantic City—Atlantic City Electric Co., has approved plans for immediate erection of new addition to steam-electric generating station, to be equipped for increased capacity. Entire project reported to cost in excess of $400,000.

N. J., Bendix—Air Associates, Inc., Garden City, L. I., N. Y., plan installation of electric power equipment in new one and two-story plant at Bendix for production of aircraft parts and equipment. Entire project will cost about $300,000. Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, will design structure and supervise erection.

N. J., Caldwell—Curtiss-Wright Corporation, 30 Rockefeller Plaza, New York, N. Y., plans boiler house at new one-story plant for aircraft propeller division at Caldwell, where site has been acquired. Entire project will cost about $150,000. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer. Proposed to begin work soon.

N. Y., Sidney—Scintilla Magneto Co., Inc., a subsidiary of Bendix Aviation Corporation, South Bend, Ind.,

"Freedom from maintenance for two years . . ."

Eastern manufacturer overcomes plant water supply trouble and reduces power cost by installing Brassert Automatic Self-Cleaning Strainers.

IMPROVEMENT in Plant water condition became evident immediately after this manufacturer installed two Brassert Automatic Strainers. Before this installation the operators had to open the condensers and clean them at least once a week; after Brassert Strainers were in, cleaning requirements were cut to once in six months.

Now, after continuous operation for two years, the Plant Engineer can point with pride to his specification of Brassert Strainers: they have done the job—and have required no upkeep. They effectively remove suspended solids from liquids, operate continuously without shut downs or manual cleaning, —and do so at low cost.

Ask for Bulletin PE which gives complete specifications

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ENGINEERS AND CONTRACTORS
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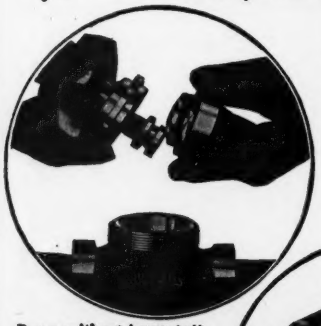
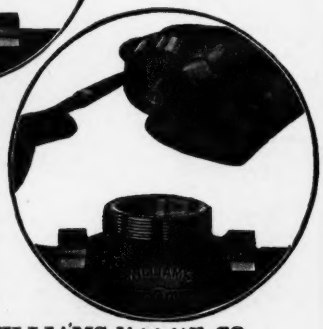
Use VULCODISC
for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

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THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

plans installation of electric power equipment in three new additions to plant, for which superstructure will begin soon. Entire project is reported to cost in excess of $150,000.

Ohio, Xenia—Hooven & Allison Co., Huit Street, plans new power house at rope and cordage mill, with installation of two Diesel engine-generator units and auxiliary equipment for power service at mill. Proposed to begin work soon. Carl J. Kiefer, Inc., Schmidt Building, Cincinnati, Ohio, is consulting engineer.

Ohio, Caldwell—City Council plans expansion and improvements in municipal power plant, including installation of new Diesel engine-generator unit and auxiliary equipment. Cost estimated about $55,000. Proposed to begin work soon.

Ohio, Mount Vernon — Shellmar Products Co., Mount Vernon, plans installation of electric power equipment in new two-story addition, 125 x 200 ft., to cellophane products and converting plant, and one-story extension, 21 x 80 ft. Entire project will cost over $125,000. Main offices of company are at 224 South Michigan Avenue, Chicago, Ill.

Ore., Eugene—Aberdeen Plywood Co., Aberdeen, Wash., plans boiler plant in connection with new plywood mill at Eugene. Main mill will comprise several large units; power equipment will be installed for operation. Entire project is reported to cost over $500,000. Morris Sekstrom is president.

Ore., Vale—Malheur Electric Co-operative Association, Vale, C. S. Harris, secretary, has plans maturing for power plant for electric service for rural electrification system, now in course of construction. Fund of $30,000 has been secured through Federal aid to apply on project. Proposed to begin work soon.

Pa., Reading—Carpenter Steel Co., plans installation of electric power equipment in new one-story addition to West Shore mill on Schuylkill River, for expansion in wire-manufacturing division. Also will install conveying and other mechanical-handling equipment. Entire project will cost about $200,000. Muhlenberg, Yerkes & Muhlenberg, Ganster Building, are architects.

S. C., Cleveland — Saluda River Lumber Co., Cleveland, plans installation of power equipment in connection with expansion and improvements in lumber mill and woodworking plant. Fund of $100,000 is being arranged for entire project. L. J. Rogers is president.

Texas, Minneola—City Council has authorized plans for new municipal power plant and electrical distribution system. Surveys and estimates of cost will be made at once. Albert C. Moore & Co., Smith-Young Tower Building, San Antonio, Tex., are consulting engineers.

Texas, Rusk—City Council has plans under way for new municipal power plant and electrical distribution system, with power substation and other operating facilities. Bond issue of $195,000 has been authorized for project. Proposed to begin work soon. H. B. Gieb & Co., Mercantile Building, Dallas, Tex., are consulting engineers.

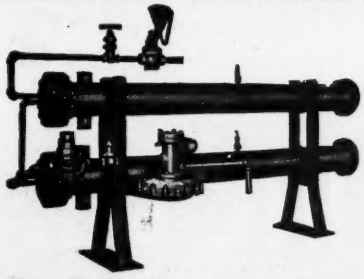
Va., Marion—State Hospital Board, Richmond, Va., plans extensions and improvements in steam power house at Southeastern State Hospital, Marion, including installation of equipment. Work will be carried out in conjunction with other expansion and modernization at instation, for which a gross fund of about $160,000 has been arranged.

Wash., Seattle — Boeing Aircraft Co., 7901 East Marginal Way, plans installation of electric power equipment in new one and two-story addition, 225 x 650 ft., for parts production and assembling; also will install cranes, hoists and other mechanical-handling equipment. Entire project will cost close to $2,000,000. Austin Co., Dexter-Horton Building, has erection contract.

Wis., Columbus—Columbus Municipal Utility Department has secured permission from State Public Service Commission to construct and operate a proposed municipal power plant. Proposed to have plans prepared soon. Diesel engine-generator units and auxiliary equipment will be used. Entire project estimated to cost about $230,000.

Wyo., Afton—Star Valley Light & Power Co., Afton, has plans for new hydroelectric generating plant on Swift Creek, Wyoming National Forest. Station will be located on Federal lands and permission to proceed with project has been granted by Federal Power Commission. A transmission line will be built to Afton, which will secure power from this source in future. Proposed to begin work soon.

HENSZEY CONTINUOUS BLOWDOWN



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- *CLEAN BOILERS*
- *CLEAN WATER*
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Clean Boilers mean: No boiler scale • Less labor cleaning boilers • Lower fuel bill • Greater boiler capacity • Better circulation • Increased life for boilers • No tube burns • Longer period between shut downs.

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The Henszey System does all this continuously, automatically, and *without heat loss!*

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HENSZEY CO.
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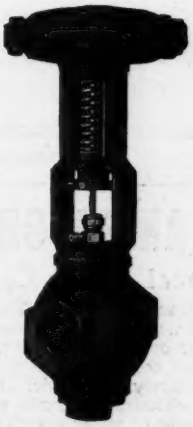
HENSZEY

Constant-Pressure PUMP GOVERNOR

The governor here shown will so control the speed of any steam-driven pump that discharge pressure will be kept constant. The diaphragm is connected to the discharge pipe, carrying oil, ammonia, other liquid, or gas, while the governor valve is installed in the steam line. Any slight variation of discharge pressure on the diaphragm is communicated to the valve, the speed of the pump goes up or down, and discharge pressure returns to normal. Both spring-weighted and lever-weighted types of governor are built. Write for Bulletin 4096.



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Buromin Company, The
Calgon, Inc.
Dearborn Chemical Company
Elgin Softener Corporation
Garratt-Callahan, Inc.
National Aluminate Corp.
Permutit Co., The

CHIMNEYS
American Chimney Corp.

CLEANING COMPOUNDS
Calgon, Inc.
Dearborn Chemical Company

COAL CRUSHERS
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